THE DETERMINATION OF THE IN SITU BEHAVIOUR OF BACKFILL RIBS IN DEEP LEVEL GOLD MINES

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DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science in Engineering at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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(Signature of candidate)

3RD day of MARCH 1993

Abstract

An understanding of the performance of uncemented backfills used for support in deep level South African gold mines is essential in evaluating the effectiveness of this support medium. Three main types of uncemented backfill material have been used for underground support in deep level gold mines. They are full plant de-watered tailings, full plant classified tailings and comminuted waste. The purpose of this dissertation is to document the data on the performance of all three of these types of backfill that have been collected at many underground sites, and to present an analysis of their general three dimensional behaviour. Backfill performance data were collected in situ using instrumentation developed by COMRO (Chamber of Mines Research Organisation of South Africa) and include stresses in three orthogonal directions inside the backfill at different depths into the backfill, and closures measured at similar positions. The results of the monitoring programme suggest that highest stresses are recorded a short distance into the backfill, that extremely high stresses are carried by backfills when highly compressed and that, for a short distance from the edge of the backfill, only low stresses are generated in the backfill. Laboratory work in which uncemented backfill material was compressed confirmed the validity of the field measurements. The results are useful for verifying constitutive laws for backfill characteristics which may be implemented in numerical models.

To my wife Jennifer and children Carmen, Lara and Stephen.

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The stress and closure measurements underground and in the laboratory were made possible by the development of the instrumentation which was designed and perfected by Mr R Maritz of COMRO. His contribution to the research is appreciated greatly. Messrs R Maritz and P Swart were also of great assistance in the laboratory work.

Terms used in the text.

Some of the terminology associated with backfilling technology and used in the text are listed below:

Backfill bag - a geotextile sausage which is open at one end to allow filling. On filling the bag should fill the void between footwall and hanging wall.

Backfill paddock - the area of containment of backfill, normally dewatered tailings. Geotextile fabrics are suspended between the hangingwall and the footwall and secured to the hanging wall with glue.

Backfill rib - formed by the continuous placement of backfill in paddocks or bags.

Classified tailings - full plant tailings which have had the fine fraction of particles rem ed by means of a cyclone and the material that is fed to the stope by gravity.

Closure - the combined elastic and inelastic movement of the hangingwall and footwall normal to the reef plane.

Closure-ride station - a measuring point established in a stope with three pegs forming a right angled triangle with sides of established lengths on the hangingwall of the stope. One peg is placed on the footwall below the right angle of the hangingwall triangle. Measurements are taken between each of the hangingwall pegs and the footwall peg; by triangulation calculations, closures and relative dip and strike movements of the hangingwall and footwall can be established.

Comminuted waste backfill - waste rock which is crushed underground and to which water is added before being pumped into the stope at a specific gravity of 1,95-2,05.

Confined compression behaviour - when sufficient backfill surrounds the measuring position, usually > 5 times the height of the backfill, the material is considered to be confined and exhibits confined compression behaviour.

Deviatoric stress - the difference between any two stresses. Used in the text to describe the difference between the stresses measured perpendicular to the reef and those stresses measured in the plane of the reef.

Dewatered backfill - full plant tailings that have been dewatered, usually underground by centrifuges, disc filters or belt filters. The backfill is usually pumped into the stope.

Dip - defined as the inclination from the horizontal. Water will flow parallel to the dip direction in a stope.

FLAC - Fast Lagrangian Analysis of Continua. A finite difference scheme for solving two-dimensional, non-elastic, non-linear problems.

Footwall - the floor of a stope or tunnel.

Gully - an excavation created underground in a stope for access and cleaning of the stope. A gully is normally developed on dip or on strike.

Hangingwall - the roof of a stope or tunnel.

K-ratios	- the ratio of the horizontal stresses to the vertical stresses. The term is used in the text as a special case to denote the ratio of stresses in the plane of the reef to those stresses acting perpendicular to the reef, measured in the backfill.
Longwall	- a number of panels advancing together, usually in a strict sequence.
Mechanical closure meter	- an instrument consisting of telescopic pipes attached to which is a wire inside a reinforced casing, that is drawn into the pipes as they telescope during compression. The instrument can be placed inside the backfill material with the wire and casing protruding from the backfill. Thus the closure at such a point can be read remotely by noting changes in the length of the wire.
MINSIM-D	- boundary element computational method for solving problems in elastic mediums.
Partially confined behaviour	- if the position at which the behaviour of the backfill is being monitored is surrounded by < 5 times the height of the material, then the material displays partially confined behaviour.
Permanent support	- support which is installed in a stope for strata control purposes and that is not later removed.
Porosity	- the volume of the material that consists of voids, as a percentage of the total volume, expressed as a percentage.
Ride	- the movement of the hangingwall relative to the footwall measured in the plane of the reef.

Strike	- any horizontal line at right angles to the dip direction.
Transition zone	- the zone near the edge of the backfill rib that experiences the highest stress, measured perpendicular to the reef plane.
Travelling way	- an excavation specifically set aside for the purpose of providing safe access and exit to personnel.
Triaxial measuring station	- a position inside the backfill at which stresses are measured in three orthogonal directions to each other. The stress cells are positioned on a wire cage so that they are sufficiently far enough away from each other not to influence one another.
Yielding elongate support	- timber support that is installed with the grain of the wood at right angles to the stope. The units are able to yield because of profiling or slotting of the prop, yet exhibit initial stiff behaviour.

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1 INTRODUCTION

1.1 EARLY USE OF BACKFILLING IN SOUTH AFRICAN GOLD MINES

As early as 1909 backfilling with sand was an accepted method of supporting mine openings in the South African gold mining industry which had sprung up around Johannesburg (Patchet,1983). However, the use of tailings sand to fill old workings dates back to 1888 at the Wemmer section of the Village Main Reef Mine (Maxwell,1988). The sand was placed underground by either pouring it directly into the stope from the surface via boreholes or by using wooden pipes to transport a mixture of sand and water to the stope down vertical or inclined shafts. Paddocks constructed out of timber and coconut matting retained and allowed the sand to de-water (Maxwell,1988). There was no means of compacting the sand in situ and little attention was given to the design of the fill as far as its quality, grading or placed porosity was concerned. The sand used was a cheap and convenient way of assisting in strata control in room and pillar mining. Patchet (1983) notes that the sand filling was used to reinforce shaft pillars and for regional ground support, although it was used near mining faces on occasion.

Backfilling continued to be used extensively in South African gold mines up until the 1940s (Piper, 1991). Problems with transportation of sandfill to the stope and placing it close enough to the working face to provide adequate support are cited as reasons for the slow decline in the popularity of sandfilling and increased interest in waste-stowing in that decade.

The difficulties arose mainly as a result of the increased mining depths and the increased closure rates associated with these depths (Piper, 1991).

The use of sand as a support medium underground died out with the advent of all-slime milling (Patchet, 1983). Maxwell (1988) also suggests that the use of sand filling ceased because of the difficulty of implementation, lack of sand and a concern over safety. If hydraulic props and elongate support units had been available for face support, they would have been able to provide stiff support close to the face while the backfill was still uncompressed and therefore soft. At that stage hydraulic props had not yet been invented and yielding elongate support had not been recognised as an effective means of rapidly obtaining stiff permanent support. Transportation and containment of hydraulically placed fills had also not been tested and, therefore, the use of tailings for support was not considered viable. The use of tailings would have been useful as an areal support, and for confinement of the pillars which were often left purposefully, and due to mining difficulties. Especially at the shallow depths that were being mined, large hangingwall collapses between vertically oriented joints may have been minimised by the placing of an areal type support such as backfill.

Timber support therefore continued to grow in use as the almost sole means of stope support in non room and pillar mining operations in South African mines until the 1970s (Piper, 1991), when mines again began to examine the use of backfill as a means of support. This occurred against a background of rising working costs on the mines, amongst which were support costs. In addition, timber companies were predicting impending timber shortages, and rockbursts were increasing in frequency as the average depth of mining increased in the gold mines. Strategies to effectively combat deaths due to rockbursts were continually being investigated and backfilling of stopes appeared to be a viable option for the amelioration of rockburst damage. The environment underground was also becoming a more pressing issue with the increasing depth of mining. The control of air at greater depths far from air intake shafts and the re[illegible]tion of the potential fire risk strongly influenced the reintroduction of backfill as support in stopes. The reduction in the number and size of large waste dumps on surface, through the use of the material as backfill underground, made good environmental sense and added to the renewed interest in backfilling. Hydraulically placed backfill was perceived by the gold mining industry to be one strategy which had potential to address one or all of these problems.

1.2 RENEWED INTEREST IN BACKFILLING AFTER 1970

By the 1970s the technology existed to pump, place and contain hydraulically transported backfills as permanent support in advancing breast panels; these are panels advanced on strike which thus allow the placement of backfill in dip oriented bags or paddocks. Hydraulic props capable of effectively supporting the working face had also been used and tested sufficiently, providing a support method which could be used in conjunction with backfill; it had been established by this time that as backfill is initially fairly soft, it did not supply the necessary support resistance near the face.

A variety of types of backfill were investigated for use underground. Dewatered fills were thought to be most suitable (Patchet, 1978) and a number of methods of dewatering the material, including centrifuges, belt filters and disc filters, were investigated. Other workers (Close and Klokow, 1985, and Bruce and Klokow, 1988) pursued both the dewatered tailings and the classified tailings options. The latter scheme necessitated the development of geotextiles to allow for the dewatering of the backfill in situ. Work on comminuted waste materials as a means of support was investigated at the then Chamber of Mines Research Organisation (now COMRO) (Bradley et al., 1982). The use of cemented tailings and aggregate cement mixtures was also proposed by researchers at COMRO (Guise-Brown et al., 1976 and Clark, 1986), and a mixture of deslimed tailings and crushed plant material was investigated (Clark, 1985).

Most of the research reports emanating from the 1970s and early 1980s backfill research were concerned with the implementation of backfill systems and a discussion on the observed benefits related to strata control in stopes subjected to seismic and aseismic conditions. These valuable observations were subjective because few quantitative studies were conducted, but rather descriptions of conditions and damage as seen by the observer were provided. A qualification of the benefits and the measured performance of the backfill in situ were therefore lacking; these aspects are essential for objectively assessing the contribution of backfilling to safer mining. Also, the financial ramifications of implementing a backfill system on a particular mine are more easily borne if there is substantial evidence of its measurable benefit to the mine.

1.3 OBJECTIVE OF THE INVESTIGATION

The objective of this dissertation is to record the in situ, three dimensional performance of three different types of backfill commonly used in the South African mining industry. In particular, the work deals with the stress-strain and volume change characteristics of backfill as closure occurrs in a backfilled stope and the backfill is loaded by the rock mass. Other aspects of the performance of backfill have been discussed by other researchers in this field. The effect of backfill as regional support is discussed by Piper (1991). He used extensive computer simulations to show the role of backfill and stabilising pillars at various depths, with different percentages of the mined areas backfilled. The influence of backfill on safety and productivity is discussed by Gürtunca and Squelch (1991). They demonstrate the importance of filling at least 70 % of the available mined slot in order to improve the safety of stopes above current safety levels. The performance of backfill in seismic conditions is covered by Spottiswoode and Churcher (1988) and Adams et al. (1990). These two papers examine seismic data collected from unfilled stopes, backfilled stopes and off-reef excavations close to these stopes. The presence of backfill had the effect of generally damping the vibration magnitude and time in a stope. Some aspects of the stress strain behaviour of the three main backfill types viz. classified tailings backfill, dewatered backfill and comminuted backfill, have also been investigated and discussed by various researchers (Clark et al., 1988, Gürtunca et al., 1989 and Gürtunca and Squelch, 1990).

The subject of this dissertation is based on and makes use of data obtained from underground field sites established by COMRO for the three types of backfill material referred to above. The results of this dissertation provide a thorough appreciation of the three-dimensional performance of the various backfills with time and with strain.

1.4 EXPECTED BENEFITS OF THE INVESTIGATION

Backfill is increasingly being used on deep level South African gold mines for support in stoped-out areas. To optimise the benefits of backfill, it is necessary to understand the ability of the various backfill materials to act as local or regional support or as both. In addition, as new mines are planned, to effectively incorporate backfill into the mine design, knowledge of the contribution of the backfill material as regional support, to reducing stresses on the faces is essential. This investigation seeks to provide that information on the performance of the three backfill types used in South Africa at present, which is necessary to enable mine designers to optimise their mine layout using backfill.

1.5 OUTLINE OF THE DISSERTATION

The dissertation continues in Chapter 2 with a literature survey of overseas and South African experience in determining the performance of backfill materials using in situ measuring equipment. Chapter 3 deals with the sites at which data were collected and the methods of data collection. The results of the field measurements are presented in Chapter 4. Since the presence of a stress cell in the backfill medium may have influenced the stresses acting at that position in the backfill, laboratory work was carried out to ascertain the importance of the inclination of stress cells to the principal stress trajectories and the modification of the stress field by the stress cell; this work is described in Chapter 5. Chapter 6 is a short section describing the numerical modelling using MINSIM-D, a boundary element program developed by COMRO. The modelling was carried out to determine the possible stress trajectories at one of the field sites.

In Chapter 7 an evaluation of the results of the in situ data is presented, followed by the application of the results in Chapter 8. The conclusions and references are contained in Chapters 9 and 10 respectively.

Appendix A contains the data files of the stresses, closures and rides measured at the underground backfill sites. The conclusions of this dissertation were reached using this data. Appendix B contains the data files used in the numerical models utilised in this dissertation. A glossary of terms used in the text are included at the beginning of the dissertation, between the Acknowledgements and the Table of Content.

2 LITERATURE SURVEY

2.1 OVERSEAS LITERATURE

Mining operations in the Coeur d'Alene area of Idaho, USA have utilized backfill as support for many years at depths below surface of as much as 2100 m. However, the ore bodies differ from those in South Africa in that they are usually near vertical ore bodies which are a metre to tens of metres wide, rather than shallow dipping tabular deposits. Cut and fill mining operations are carried out in near vertical seams. Similarly to deep level South African gold mines, the mines of this district experience rockbursts (Patchet, 1983) at high percentage extraction ratios. Backfilling was seen as a means of controlling seismicity and rockburst damage, and also as a method of supporting the incompetent sidewalls of the vertical stopes where the horizontal stresses are higher than the vertical stresses. Fortunately these mines realised the importance of measuring and documenting the in situ behaviour of the backfills which were being placed in the stopes.

Studies of the in situ performance of backfills underground have also been carried out in the Sudbury area in Canada, at Mt. Isa mine in Australia, in Sweden and in Zambia (Patchet, 1983). At the Kamoto Mine in Zaire in situ measurements obtained from mechanical extensometers and hydraulic cells installed in backfill indicated good agreement with computer modelling (Patchet, 1983).

A Bureau of Mines research programme for monitoring in situ backfill behaviour was started in 1961, mainly in the mines of the Coeur d'Alene district in Idaho, USA. The in situ monitoring work included recording the pressure build-up in the backfill and measurement of vein wall deformations (McNay and Corson, 1961). Research was conducted into the performance of the backfill in order to assess its contribution to carrying stresses caused by closure of the stope's sidewalls. Such stresses would otherwise be carried by the intact rock surrounding the mining and by specially designed stability pillars left between mined-out stopes. The stability or crown pillars tie up valuable reserves and any reduction in the stresses carried by these would mean a reduction in the pillar size.

Hydraulic pressure cells filled with glycerine were placed in the backfill to measure the direct stresses acting on the pressure cel. . rather than measuring strains and converting these to stresses. Laboratory tests on similar gauges were carried out to interpret in situ data at maximum and minimum backfill densities.

Gauges in the range 3 MPa to 6 MPa were used, and results were found to be reliable in the 2,5 to 4 MPa range. The instrument could not be repaired once installed and it was found that cells could shift out of their original alignment with stope wall closure.

Borehole pressure cells were used to monitor rock pressure changes adjacent to the backfilled areas.

This was done automatically with full bridge strain gauge type pressure transducers, and readings were recorded continuously on strip chart recorders.

Stope wall closures were measured between rockbolts installed in opposite walls. A dial extensometer was used in the measurement where the bolts protruded into the travellingways. Another method of measuring closure was to use stainless steel wire attached to rockbolts.

Total stope wall closure was measured using a hydraulic cylinder which displaced fluid into a container. The quantity of fluid was recorded regularly and equated to a certain amount of displacement.

A monitoring programme at the Star Mine in Idaho, USA, covered an area 60m x 40 m in a near vertical vein. Corson and Wayment (1967) discuss the experiment in detail at this mine, and in particular the stress versus displacement measurements in a backfilled stope at a depth of more than 2000 m.

In this experiment 22 pressure-meters and six closure stations were deployed to collect data. The vein was approximately 3 m wide. Cuts of approximately 3 m were made into the ore. Stresses in the backfill initially developed hydrostatically but then pressures acrosss the vein increased more rapidly than in the plane of the ore. The maximum stress measured across the vein was 3,5 MPa, while the stresses in the plane of the vein in the horizontal and vertical directions only reached 1 MPa, at which level the cells broke. Closures recorded in the stope were about 10 cm.

M^{c}Nay and Corson (1961) also report on monitoring of backfill stresses and strains at the Lucky Friday Mine at Mullen, Idaho, in the USA. Mining was taking place at a depth of approximately 1300 m and five backfilled areas were instrumented, with readings taken, at first, weekly and then biweekly. A miners strike and the delay in production resulted in very little increase in the pressure in the backfill. However, when mining recommenced, rockbursts were experienced and increased pressure in the backfill was noted. The rate of strain also increased following the rockbursts. A maximum pressure of approximately 5 MPa was measured in the backfill at this site.

At Geco Mine, mining took place at approximately 600 m depth. Extensometers were used in the rock surrounding the backfilled stope to obtain an estimation of the behaviour of the rockmass surrounding a backfilled stope.

Corson (1971) reports on a field evaluation of backfill compaction at the Lucky Friday Mine, where monitoring of two stopes filled in different ways was undertaken. This lead-silver mine which reaches a depth of approximately 1200 m uses classified mill tailings with a specific gravity of 2,3. Two sites separated by 30 m on the same elevation were used at a depth of 1000 m. Both sites were filled with cemented fills but at the one site backfill was placed normally while the other was densified by vibration. At each site six pressure cells were placed inside the backfill and a mechanical closure device was used to measure the vein wall movements. An access pipe was also used to measure density and moisture at three elevations, and monitoring continued for four years. The author (Corson, 1971) reports that instrumentation had to be modified to cope with the hostile environment. Improved pressure build up and strain characteristics were reported for the vibrated product.

Piciacchia et al. (1989) discuss in [illegible]cing in underground backfilled stopes, including a method of measuring effective strength and stiffness of backfill in a stope. Their purpose was to understand the stability of fill for ground control and in particular pillar recoveries. At the same time an idea of the quality of the fill was obtained. It was appreciated that reliable in situ data would be useful in numerical modelling to assist in good mine design and application of correct rock mechanics principles. They suggested that the data should be used in numerical models to assess the effectiveness of backfill as support as well as to obtain an idea of the stresses in pillars surrounded by backfill.

Further recent work on determining the in situ behaviour of high density fill under load has been carried out by Thibodeau (1989) in Canada. The instrumentation consisted of 36 electronic total earth pressure cells, three electronic piezometers, two Young's modulus cells and seven convergence monitors, amongst other instruments. Monitoring was carried out on an hourly basis for almost a year. The objective of the monitoring programme was to establish whether the lateral loads carried by the backfill were attributable only to beam theory. The results suggest that this was not the case.

Measuring of stresses in backfills used in civil engineering applications has been carried-out by Carder et al. (1977). They describe an experimental retaining wall facility and their procedure for lateral stress measurements in sand backfill, which was carried out for the Transport and Road Research Laboratory in Britain. These authors used an articulated steel plate which m[illegible] out of the soil sample in the laboratory. This measuring was carried out outside the fill in the wall of the container accommodating the backfill. Three types of stress measuring device were used, viz. hydraulic and pneumatic load cells, and electrical resistance strain gauges. The load cells, 140 mm in diameter, were mounted flush with the walls of the container, which were concrete or steel. There were three columns with six cells of each type. A maximum stress of 25 kPa was measured and fairly good agreement was obtained between all three types of cells and between the steel and concrete walls.

The measurement of stresses and strains to which embankment dams are subjected during and after construction has been considered to be important for the stability of these dams and has contributed to the development of apparatus to acquire such measurements. In the twenty sixth Rankine Lecture, Penman (1986) discussed the use of four different types of stress meters which have been used in obtaining stress measurements in embankment dam walls.

The first instrument which Penman (1986) describes is an oil filled, 610 mm diameter x 25 mm thick cell developed by the Waterways Experimental Station. The cell was more compressible than are most fills, with the load being transmitted through the oil to a diaphragm fitted with resistance strain gauges. These cells were used as far back as the 1940s to measure the vertical stresses in embankment dams. Only vertical stresses of under 1 MPa were measured with this type of instrument.

It was suggested that the compressibility of the stress cells was not a problem as far as obtaining realistic stress measurements, but rather that the correct placement of a cell determined the quality of the data obtained. The cells were reported to have lasted for up to two years.

Penman (1986) describes a second type of stress cell developed by the Swedish State Power Board. This instrument was 270 mm diameter x 20 mm thick, was oil filled and the pressure in the oil was read off a pressure gauge attached to the cell by a brass tube. Although criticized for being temperature sensitive it was found that, once it was buried, the temperature remained almost constant. These stress cells were used to measure horizontal and vertical stresses in the clay cores of dams.

A third type of stress cell which was developed by the Building Research Station is described by Penman (1986). The cell was 280 mm diameter x 38 mm thick and utilised vibrating wire strain gauges which measured the deflections of a stiff diaphragm on both faces of the cell. The cells were used to measure horizontal and vertical stresses, and stresses at 45° to these two directions. The instruments were designed to measure stresses below 1 MPa and measurements were possible for at least three years, with some of the instruments only failing after 10 years. Results of these measurements revealed that the horizontal stresses were about 0,6 - 0,7 σ_v, and the stresses measured at 45° to the horizontal and vertical cells were 0,7 - 0,8 σ_v. From these measurements it appears that the magnitude of stress increased as the angle increased from the horizontal. It was not clear, however, if the change is linear.

The fourth type of earth pressure cell which Penman (1986) describes is the Glötzl cell (250 mm diameter x 10 mm thick). The cell is pressurised until the pressure inside the cell just exceeds the pressure acting on the cell. When this occurs, a diaphragm is forced open and the pressure in the cell is not able to develop any higher. Penman commended this cell for its simplicity, toughness and thinness.

Palarski, (1990) discusses in situ measurements obtained from backfilling in Polish coal mines. He presents a stress profile across a backfill rib that is zero at the edge and rises progressively to a maximum at the centre of the paddock. It is unclear how many measuring stations the stress profile was constructed from, but it is very similar to those first constructed for South African backfills by Gürtunca et al. (1989), based on limited measuring stations across backfill ribs. It may be that the behaviour of backfills in Polish coal mines, however, is markedly different from those used in South Africa, given the softer rocks being mined and shallower depths of mining in Poland.

The stresses measured at backfill sites outside South Africa were all of much lower magnitude than those expected in deep level South African gold mines. Therefore, the project undertaken by COMRO presented a unique opportunity to record the stress strain behaviour of backfills under much more severe conditions in the field.

2.2 SOUTH AFRICAN LITERATURE

Gay et al. (1988), in their evaluation of fill performance in South African gold mines, documented the first known measurements of stresses and displacements in backfill in South African gold mines. They explain the development of the various instruments suggested by Greig et al. (1979) of COMRO (Chamber of Mines Research Organisation) for recording stresses and strains in the harsh underground environment.

Gay et al. (1988) appreciated that in attempting to measure stresses in the backfill there would be two ranges of stresses which would have to be measured. Firstly, if the backfill was simply acting as a local support the stresses would be less than 10 MPa. However, if the backfill acted as a regional support, the stresses could be expected to exceed 100 MPa at 4 - 5 km depth, which would approximate the pre-mining virgin stress (Gay et al., 1988). In the investigation into the types of instruments which were needed to measure the anticipated high stresses and strains in deep level gold mines (Greig et al. 1979), four parameters were selected which it was felt should be measured in backfills, viz. closure, stress in vertical and strike planes, pore water pressure and horizontal displacement.

At the time no suitable instruments were commercially available for the task of measuring the closures, stresses or horizontal movements. In addition there was no prior experience of measuring the high stresses anticipated at great depths. The COMRO developed instruments worked on the principle of an oil filled flat jack, and the fluid pressure in the flat jack was read with a hydraulic stress gauge or by utilising a stress transducer which produced an electrical signal. Both systems could be read remotely outside the backfilled area.

The original COMRO instrumentation, and the commercially available instruments for measuring stress, failed after a short time underground, and therefore tests were carried out in backfill placed in a laboratory press in order to overcome some of the weaknesses experienced with the instrumentation underground.

Difficulties were also experienced with the closure meters developed by COMRO, from which the backfill strains were calculated. Two types of instruments were used: the one being a mechanical telescopic device and the other operating with an electric potentiometer. Both were read outside the backfill, remote from the instrument location, by running a steel wire and electrical cable respectively, through the backfill inside a protective sheath capable of sustaining up to 80 MPa before failing. Gay et al. (1988) reported that both types of closure instruments suffered failure due to shear movements and their slenderness ratio, and that other methods of measuring closure would have to be investigated.

Two other means for determining the stresses in backfill are discussed by Gay et al. (1988). The first is the Goodman Jack method which in preliminary in situ tests showed potential for measuring the backfill stiffness. The second method described is a hydraulic packer, and laboratory tests suggest that minimum principal stresses and fill stiffness values may be obtained from this type of test (Gay et al., 1988).

The results reported by Gay et al. (1988) are only for the stresses acting at right angles to the stope, although they specifically state that three orthogonal cells were placed in the backfill. It can thus be assumed that because of instrument failures due to the adverse conditions underground, no readings were obtained from the stress cells positioned at right angles to the reef to measure dip and strike stresses in the plane of the reef. The stress readings which were carried out did not clearly indicate any differences which may have been due to the positions of the measuring stations relative to the centre or edge of backfill ribs.

Although Gay et al. (1988) recognised the important differences in the behaviour of the backfill in confined or unconfined conditions both underground and in the laboratory, their data were insufficient to indicate whether the backfill was behaving as a confined or an unconfined material. The measured stresses were plotted against face advance and computed strains rather than measured strains, probably due to the difficulties of obtaining a reliable method of measuring closure adjacent to the stress cells.

The highest vertical stress readings obtained by Gay, et al. (1988) was about 35 MPa and this was obtained using a commercially available Glötzl cell. The highest vertical stress recorded by a COMRO type stress-meter at the same location was 12 MPa.

No attempt is made by Gay et al. (1988) to discuss or provide any details of the relationship between the horizontal stresses and the vertical stresses in the backfill. There was also insufficient data at their disposal to arrive at any conclusions regarding the three dimensional performance of the backfill ribs. These authors do, however, provide information regarding the dilation of the backfill edges and the general effect of backfilling on reducing closures in stopes. They also discuss an extensometer that had been developed to be placed in the backfill to monitor the dilational movement throughout the backfill rib but they do not present any information from this type of instrument.

Some of the first researchers during the 1980s to report on the use and placement of backfills were Close and Klokow (1985). However, on the rock mechanics benefits, their reporting is qualitative rather than quantitative. The authors merely discuss the reduction in the number and severity of rockbursts and improved strata control as advantages of using backfill.

Bruce and Klokow (1988) describe a monitoring programme carried out on West Driefontein mine involving backfill instrumentation. The mine manufactured its own closure meter for installation in backfill and placed it in backfill underground, some 13 m from the backfill edge. A Glötzl pressure cell was installed alongside the closure meter. The closure meter ceased to work after a short period of time and the closure inside the backfill had to be inferred from closures measured outside the backfill. Bruce and Klokow (1988) were disappointed by the apparent lack of agreement between the stress-strain curve from the field data and the curves obtained from similar material tested in the laboratory. Stresses of 3 MPa were recorded at 21 percent strain in the backfill underground while 3 MPa stress was measured in the laboratory at 16 percent strain. The difference in field and laboratory results may be due to the rate of loading of the backfill material in the laboratory which would have been far higher than underground. The stress generation is expected to be higher at a particular load in the laboratory than underground. In discussing the stress-strain behaviour of backfill, Bruce and Klokow (1988) suggest that the closure outside the backfill is greater than that inside the backfill.

Clark et al. (1988) mention that commercially available load cells are capable of measuring stresses in backfill up to only 5 MPa and that no commercial closure instruments were available. COMRO therefore developed stress meters to record stresses up to 100 MPa and closure meters to monitor up to 0,5 m of closure inside the backfill. Clark et al. (1988) presented closures and stress measurements in three orthogonal directions recorded in classified tailings backfill. The highest vertical stress recorded in the backfill was almost 30 MPa. The authors showed that the ratio of the average of the two horizontal stresses to the vertical stress remained fairly constant above a vertical stress of about 3 MPa. Clark et al. (1988) proposed that the simplest laboratory test that simulates a similar constant ratio between horizontal and vertical stresses is the confined compression or uniaxial strain test. They also present a comparison between the in situ measurements and a laboratory confined compression test on similar material. The results show good agreement. Triaxial shear tests were also performed by Clark et al. (1988) in order to establish input parameters for constitutive models to be used in numerical models. The authors demonstrate the capabilities of FLAC (Fast Lagrangian Analysis of Continua), a finite difference programme developed by

Itasca Consulting Group, Incorporated, USA, in simulating the behaviour of the backfill in a confined compression laboratory test.

Gürtunca et al. (1989) report on a backfill monitoring programme to determine the in situ behaviour of different backfill types. The in situ confined compression of three types of backfills, viz. comminuted waste, classified tailings and dewatered tailings backfill, are presented, and compared to measurements from the same three types of backfills at similar porosities in the laboratory. The good agreement between the in situ and laboratory data in confined compression is encouraging. A comparison of the in situ confined behaviour of the three types of backfill shows, in general, the stiffest type of backfill tested to be comminuted waste, primarily due to its low placement porosity. In general, the work done by Gürtunca et al. (1989) suggests that the lower the starting or placement porosity of any particular backfill, the stiffer that backfill will be. Of great importance in the paper by these authors is the first documentation of the closure profile across a backfill rib. Gürtunca et al. (1989) use the closures at a number of measuring stations along dip sections of a backfill bag or paddock to demonstrate the variable nature of closure across the backfill at selected stresses. Although the results are related directly to the backfill behaviour, they also indicate the behaviour of the rockmass surrounding the backfilled stopes.

Gürtunca et al. (1989) also present stress readings acting in the dip and strike directions in the plane of the reef. The ratios of dip or strike stresses, to stresses acting at right angles to the reef plane, referred to as the K_o ratio, are suggested by the authors to be generally between 0,3 and 0,6. They indicate that the range of K_o ratios is similar for all types of backfills and use this reasoning to justify simplifying some of the figures by omitting the horizontal stress plots.

Using the data available to them, Gürtunca et al. (1989) present simple three dimensional models for the closure and stress profiles across complete backfill ribs. The closure profiles show the maximum closures occurring near the edge of the backfill with lesser closure occurring near the backfill centre. The three dimensional stress profile model suggests that stresses in the backfill increase with increasing distance from the stope face. On any section parallel to the stope face, the stresses build up slowly from the edge of the backfill and reach a plateau of maximum stress in a central section of the backfill rib. This is in contrast to the stress profile across a rock pillar which has the highest stresses at or close to the edge of the pillar, with the stresses reaching a plateau of lowest values near the pillar centre (Hoek and Brown, 1986).

Clark (1989) succeeded in describing in more detail the actual behaviour of the backfill as it was subjected to closure and increasing stress. He investigated dewatered and classified tailings at two sites where stresses w. ɟ measured in three orthogonal directions. By plotting a number of values derived from the stresses measured in the backfill, Clark (1989) showed that the backfill appeared to go through phases of stiffness related to the ratio of the horizontal to vertical orthogonal stresses. He even suggested that the backfill experienced failure at certain times when the deviatoric stresses (defined by Clark to be $\sigma_1 - \sigma_{2or3}$) dropped. It is true that the values of the deviatoric stresses do decrease as the horizontal stresses increase without a proportional increase in the vertical stresses. However, a drop in the deviatoric stress means that the material is less prone to shear failure. In fact this decrease in the deviatoric stress is beneficial because it is indicative of the backfill becoming more confined in the horizontal direction. However, it is clear from Clark's work (1989), that the measured stresses in the backfill, whether horizontal or vertical, never decrease with time or with closure. Therefore, it is the opinion of this author that to refer to the failure of backfill at times of decreasing or static deviatoric stress values, when the backfill is accepting higher loads, is misleading and incorrect.

The data Clark (1989) dealt with were only derived from confined compression conditions. He did not consider the behaviour of the backfills across a complete dip or strike section of a rib. Closer to the edges of the backfill the material may not be confined and therefore may have a completely different characteristic behaviour.

The work carried out by Clark (1989) was aimed at gaining a better understanding of the in situ behaviour of backfills to assist in deriving a constitutive model which describes the performance of backfill. Such a constitutive model was developed for incorporation into the numerical models used for backfill simulations.

Squelch (1990) reported the results of field measurements that were obtained in classified tailings backfills on Vaal Reefs Exploration Companies gold mine. The mining method used in the Klerksdorp mining district, where Vaal Reefs is located, is that of scattered mining. This is due to the complex geology of the area, with many faults and dykes crossing the mining lease area. Classified tailings backfill is placed on Vaal Reefs in paddocks which are constructed from mine poles, wire mesh and geotextile fabrics attached to the poles and mesh, and secured to the hangingwall with glue.

The depth of the stope in which instrumentation of the backfill took place is approximately 2030 m and the dip of the reef is close to 10°. Three triax 1 stress stations with mechanical closure meters were installed in one paddock which had an average stoping width of 1,22 m in the down-dip portion where the instruments were positioned. At the time of installation of the instrumentation the face was 5 m away from the edge of the backfill. Down dip of the backfill paddock, on the gully edge, a closure-ride station was placed to monitor the closure outside the backfill compared with that inside the backfill.

Squelch (1990) was able to record stresses in the backfill up to a maximum of 4,5 MPa and closures of 130 mm. The author was able to determine the complete backfill behaviour for classified tailings backfill in spite of high shrinkage of the backfill material.

Gürtunca and Adams (1991a) report on field measurements conducted in classified and dewatered tailings backfills at West Driefontein gold mine. The authors show that there is good agreement between the measurements recorded underground in confined compression conditions and laboratory tests on similar material under comparable conditions. The stress-closure profiles across two backfill ribs were established, and the stress profiles for these two ribs at determined strains were also derived. The authors document the effect of backfilling on the closure rates in gullies and panels with and without backfilling in the immediate stope where the measurements were made. Their findings demonstrate the dramatic effect that backfilling has on reducing closure rates in gullies and in the panels of backfilled stopes. One extremely important conclusion reached by Gürtunca and Adams (1991a) is that the behaviour of the backfill is determined to a large degree by whether the material is partially confined or fully confined. The authors make use of field data converted into K_0 ratios to substantiate this view. Another useful analysis in their research was to construct, from several backfill instrument sites, a composite stress profile of the complete backfill rib behaviour, at cho en constant strains. The porosities of the material may not be precisely the same at all sites in a particular bag at similar strains. However, recorded stress-strain data have shown that all stations except those at the very edge of the backfill rib fall within a fairly narrow band around the placed porosity stress-strain curves. At constant strain, the highest stresses are recorded at or near the centre of the backfill rib, and the stresses drop off towards the edge of the backfill rib. Gürtunca and Adams (1991a) also show that the maximum and minimum closures take place at the edge of the backfill rib and at the centre of the backfill rib respectively. Finally, these authors describe, in qualitative terms, the benefits of backfill in rockburst conditions.

3 FIELD SITES

3.1 Description of the monitoring sites

It has been assumed that an approximate symmetry exists up and down dip of a strike oriented plane through the centre of the backfill bags, installed with their long axes on dip. If the reef is horizontal then this is certainly true. Numerical modelling of stopes with backfill as support, using the finite difference model FLAC, demonstrates that there is a plane of symmetry through the middle of a backfill rib (Clark et al., 1988 and Gürtunca and Clark, 1989). MINSIM-D modelling, which will be described later, shows that the stresses acting at the hangingwall along a 30 m long dip line do not increase significantly with depth. Therefore, the only difference in stresses which are measured by the instruments at similar positions but on different sides of the plane of symmetry in the bag, will be due to the backfill head in the bag. Therefore, a decision was made to only instrument one half of any bag and to extrapolate the information into the other half. The steeper the dip of the reef and the longer the backfill bag, the less true the symmetry will be, as a result of gravity. The stopes in which backfill was instrumented dip at 20 - 25°.

Because the bags are sealed at the bottom end prior to filling, in most cases the triaxial measuring stations were installed in the top half of the bag and read remotely in the gully up dip of the instrumented backfill bag. Occasionally, however, it was possible to place the instruments in the bottom half and read the instruments remotely in the gully below the bag. Placing the instruments in the lower half of the bag meant that the instruments could be placed very close to the edge of the backfill bag which was important for measuring the backfill performance in unconfined conditions. At the bottom end of the bag the backfill was in contact with the hangingwall, unlike the top end of the bag where the backfill forms a horizontal beach for a few metres. It is extremely difficult to fill the last few metres of a bag right to the hangingwall.

In general, the stresses at each station were recorded from three stress cells attached to three orthogonal sides of a rectangular wire cube. The cube was placed flat on the footwall of the stope, which means that the stress cells were parallel to the coordinate system of the reef plane (see Figure 5.1 in Section 5.1). Therefore, if the trajectories of the principal stresses were not coaxial with this coordinate system, the stresses registered by the stress meters would not be the principal stresses.

In a perfectly elastic medium with a horizontal backfilled mined-out slot, the maximum principal stress is expected to be fairly close to vertical and the minimum and intermediate principal stress trajectories will be close to horizontal. In the case of an inclined, backfilled reef plane, two of the principal stress trajectories may rotate slightly from the vertical and horizontal respectively but, the stress cells will rotate by approximately the angle of the dip of the reef. The principal stress trajectory closest to the strike of the reef will be least affected by changes in the dip of the reef, and the stress cells for measuring these stresses remain vertical irrespective of the dip of the reef.

3.1.1 Western Deep Levels

3.1.1.1 Comminuted Waste Backfill

The first reference to the use of comminuted waste in deep level South African gold mines was probably made by Lloyd (1979) when he suggested that ore should be crushed underground and the waste used for backfilling. He appreciated the economic and rock mechanics benefits of placing such backfill, but lacked specific quantitative knowledge about the behaviour of this type of backfill.

The site for the comminuted waste placement and the instrumentation programme to measure stresses and closures was at the East Mine of Western Deep Levels Mining Company. Measurements were taken from January 1988 to July 1990. The stopes in which comminuted waste were being placed were on 94 Level, approximately 2700 m below surface, in one of the longwalls advancing in an easterly direction. The stopes in question lie between two 40 m wide stabilizing pillars spaced at approximately 210 m on dip. The stoping width is usually 1 m. The mining intersected a fault and a faulted dyke during the period of backfill placement (Figure 3.1). The Big B[illegible] Fault involved a major mining disruption in its vicinity, which required re-establishing the stope on the up-thrown side of the fault, before mining could proceed. The Snowflake Dyke had a small enough throw to enable mining to proceed almost uninterrupted. The Snowflake Dyke proved to be seismically active and resulted in rockburst damage in the stope on a number of occasions.

Six panels, dipping at about 22°, were selected for carrying out the comminuted backfill instrumentation programme. The original plan was to fill four of these panels with approximately 80 percent backfill, to fill another panel with 40 percent and to have one panel with only conventional timber support (Figure 3.2). This was to enable a comparison to be made between the three scenerios and to assess the safety and strata control benefits, if any, that could be attributed directly to increased amounts of backfilling. Unfortunately, due to the lack of waste material, problems with the underground mill and pumps, and a lack of sufficient pipelines to the stope to fill the required number of panels, the plan was not implemented as desired. However, every effort was made to measure backfill stresses only where backfill ribs were continuous on strike, and where they were sufficiently wide on dip to record at least one station in confined compression conditions.

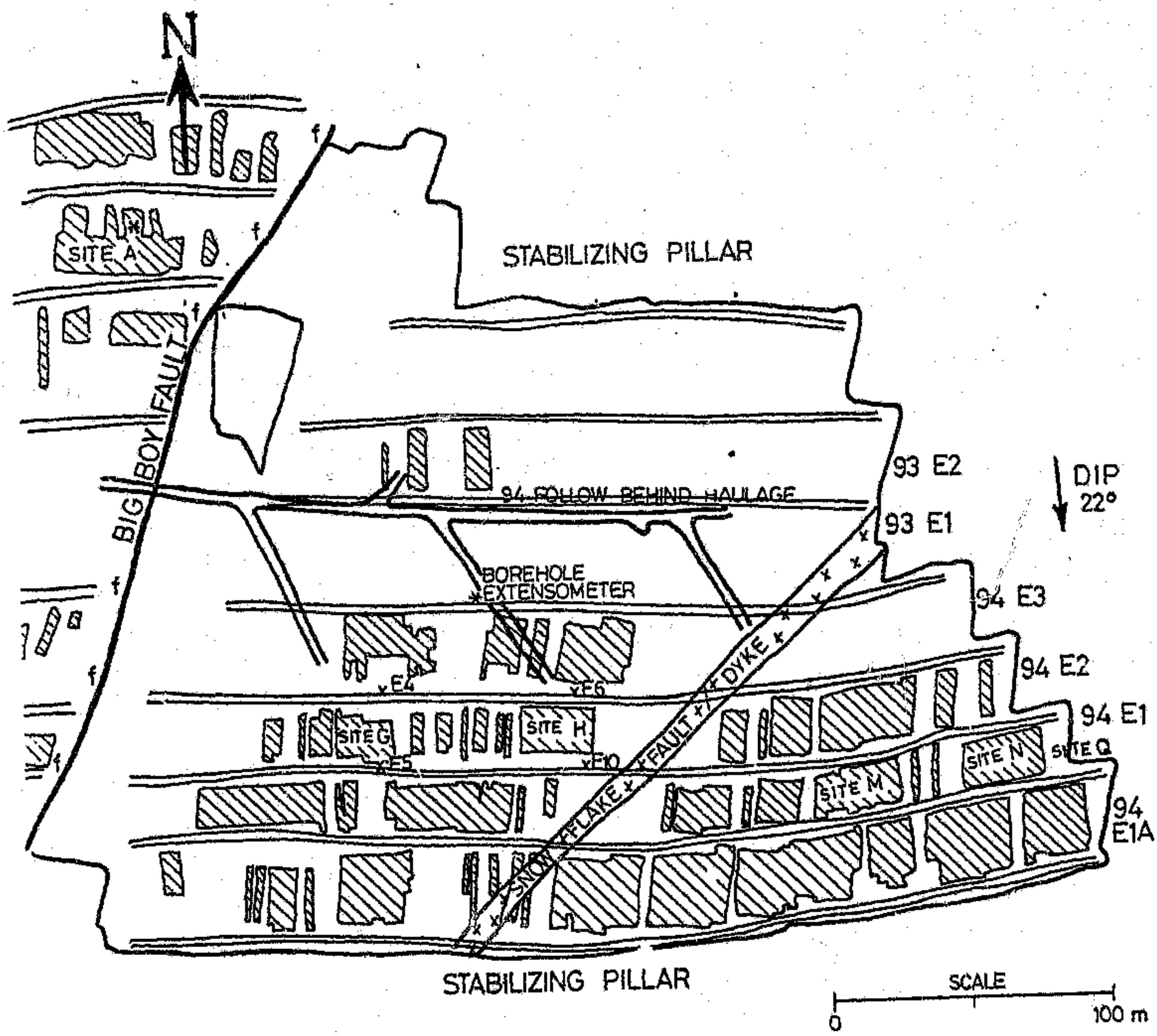

Figure 3.1 General plan layout of comminuted waste site at Western Deep Levels East Mine on 93 and 94 Levels. The shaded areas represents backfill material

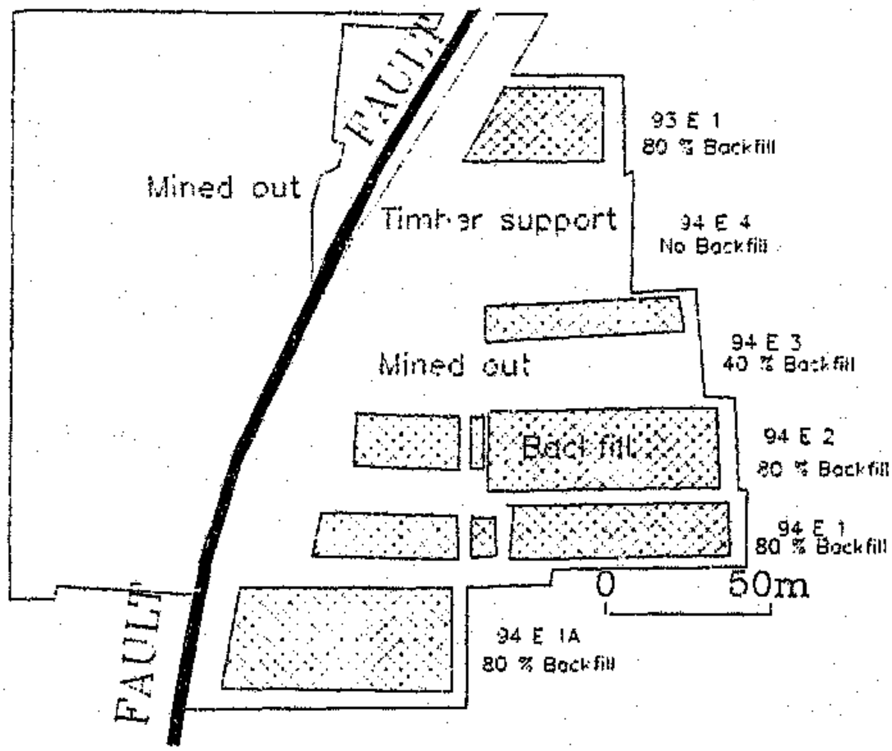

Figure 3.2 Planned layout of filled, unfilled and partially filled comminuted backfill panels to evaluate the effect of different percentages of filling

The in situ behaviour of comminuted waste fill was determined at eight sites on this mine, of which five are discussed in this work. At two of the five sites, single triaxial stations were installed, one to measure the confined compression behaviour at the centre of the backfill rib and the other to measure the unconfined compression near the edge of the backfill. The backfill rib behaviour was established at three sites.

The five sites were established beyond the Big Boy fault and at each of these at least one triaxial stress measuring station and a mechanical closure-meter were installed. Figure 3.1 shows the positions of the five sites, three of which were in 94 E1 panel and two were in 94 E2 panel. At all five sites the placed comminuted backfill had a porosity of approximately 27 percent. The backfill was pumped as a hydraulic slurry at a specific gravity of 1,95 - 2,05 into geotextile bags, positioned parallel to the face and dip. The backfill bags were 2 m wide and open only at the top end.

Figure 3.3 shows the layout of the instrumentation sites established beyond the Big Boy Fault, including Sites G and Q at which only one triaxial stress station was placed with a mechanical closure meter beside it. The backfill instrument station was installed in a 15 m long bag and surrounded by at least 6 m of backfill in all directions, which is sufficient for measuring confined compression behaviour (Bradley, 1987). The stoping width was approximately 1 m so the height to width ratio of the backfill rib was 1 to 12.

The layout of site H is shown in Figure 3.3 where four triaxial stations were positioned in the up dip half of the bag with a mechanical closure meter adjacent to each station. The

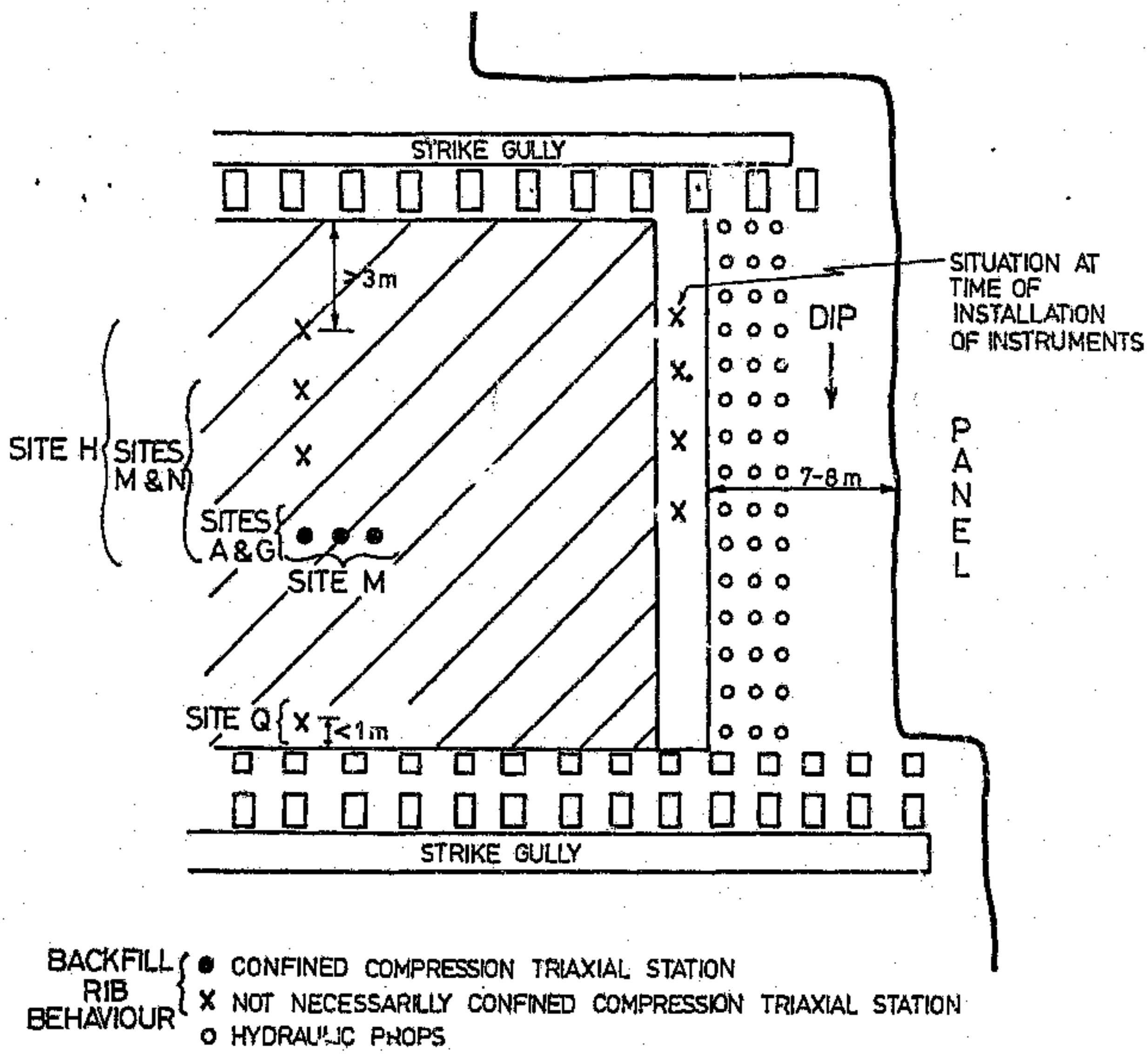

Figure 3.3 Instrument layouts for the sites established beyond the Big Boy Fault. Some sites consisted of single stations at which three orthogonal stresses and closure were read, while other sites had multiple stations.

geotextile bag in which the instruments were installed was 21 m long and the stations were positioned at 2, 5, 9 and 12 m.

Site M consisted of five triaxial stress stations and closure measuring instruments. Three stations were installed in the top half of a bag, with one of these stations at the centre of the bag. In each of the following two bags one station was installed at the centre of the bag (Figure 3.3). This was done in order to understand and compare the closure and stress reactions in a backfill rib on dip and strike.

In order to establish the backfill behaviour close to the edge of a backfill rib, Site Q was installed. One triaxial stress measuring station was placed 1 m from the down dip edge of a bag (Figure 3.3). The down dip side was chosen because of the problems of beaching at the top end of any backfill bag or paddock in stopes of dips less than about 35°.

3.1.1.2 Classified Tailings Backfill

Classified tailings backfill was instrumented on the same mine but at a shallower site than the comminuted waste site (Figure 3.4). Four separate stations were established in this type of fill. The stations are designated S, ST, P and R. The first two were located in panel 85 E1 and other two were located in 87 E2 panel (Figure 3.4). Figure 3.5 shows the layout of the stations at each of the four sites. The backfill instrumentation sites were installed in an easterly advancing longwall divided into seven panels which varied in length from 20 to 30 m long. The longwall was separated from longwalls up dip and down dip of it by 40 m wide stabilising pillars. Backfilling was used in all the panels as permanent support, and timber packs were used on the edges of all the gullies and travellingways.

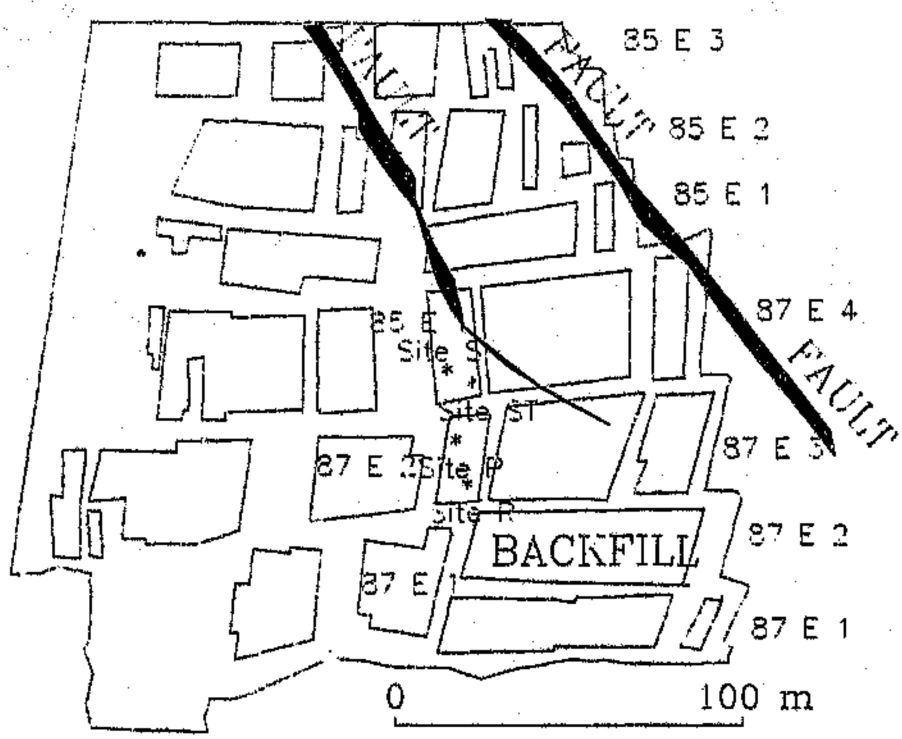

Figure 3.4 Positions of measuring sites P, R, S and ST installed in classified tailings backfill at 87 East Longwall.

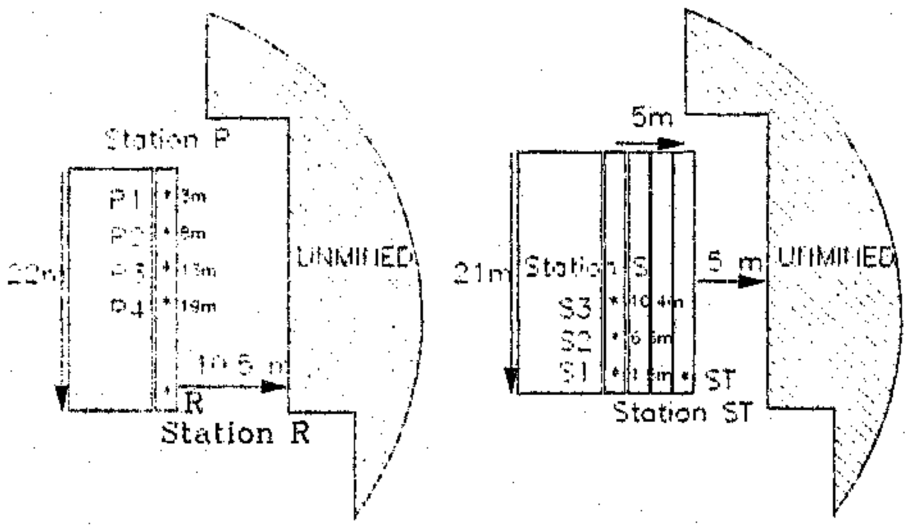

Figure 3.5 Detailed plan of Sites P and R, with four triaxial stations installed in the up-dip half of the bag and one triaxial station at the down-dip edge of the bag respectively. Sites S and ST with three and one station respectively, installed in the down-dip half of the bag are also detailed.

3.1.2 West Driefontein

West Driefontein gold mine offered the opportunity to monitor the behaviour of two types of backfill, viz. classified and dewatered backfills. At two sites dewatered tailings were initially used (one site later changed to classified tailings) and at one site classified tailings were used. The two sites at which dewatered tailings were placed and at which stress and closure measurements were taken were adjacent to the 5 West Shaft pillar and close to the 3 Sub-shaft pillar (Figure 3.6). At the 5 West Shaft pillar classified tailings backfill was later used but monitoring of this backfill type at this site is not discussed in this dissertation. Monitoring of classified tailings was carried out close to the Number 2 Shaft (Figure 3.6).

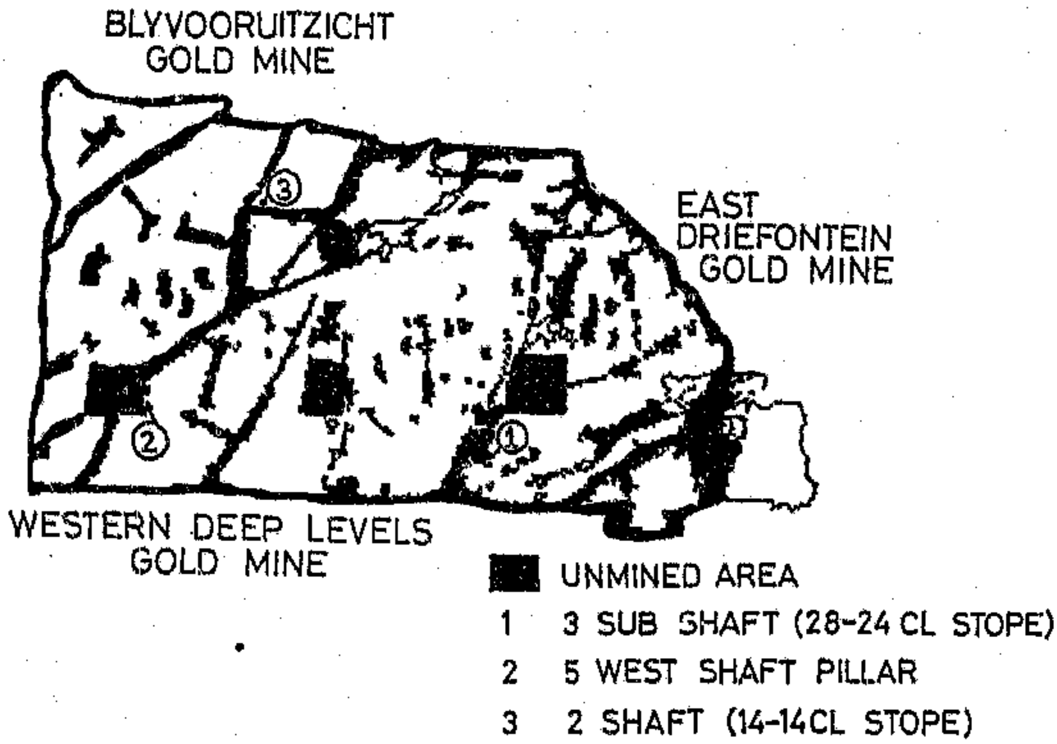

Figure 3.6 Plan of the West Driefontein mining area showing the backfill instrumentation sites

3.1.2.1 Dewatered Tailings Backfill

The 5 West Shaft Pillar site is located approximately 2000 m below surface. Mining took place on the Carbon Leader Reef which at this site dipped at about 20° to the south. Mining at this site involved the extraction of the shaft pillar which had been created by extensive mining more than 10 years previously. In 1984 an attempt was made to extract the shaft pillar, but this was stopped because of increased seismicity in the pillar, probably associated with one of the large dykes which intersects the shaft pillar. In 1986 the operation was started up again, this time with dewatered backfill with a porosity of approximately 40-43 percent. The theory suggested that extraction of the pillar was possible, with reduced seismicity and rockburst damage, if backfill was used as a support medium. The extraction of the shaft pillar was concentrated on the eastern side of the pillar by means of nine panels advancing in an underhand or bottom panels leading, configuration (Figure 3.7).

Figure 3.7 shows the positions of the instrumentation sites in the backfill ribs which were placed during mining in 28-8 C Carbon Leader stope, part of the shaft pillar. T[illegible] panels in the contract were instrumented. The first was 8 West panel (P8W), in which three Glötzl stress meters and a mechanical closure meter were positioned. At a second site in 5 West panel (P5W) three triaxial stress measuring stations were established. At each of the three sites mechanical closure meters were installed and, between two of the triaxial stations, a Glötzl stress meter was positioned to measure the vertical stress (Figure 3.8).

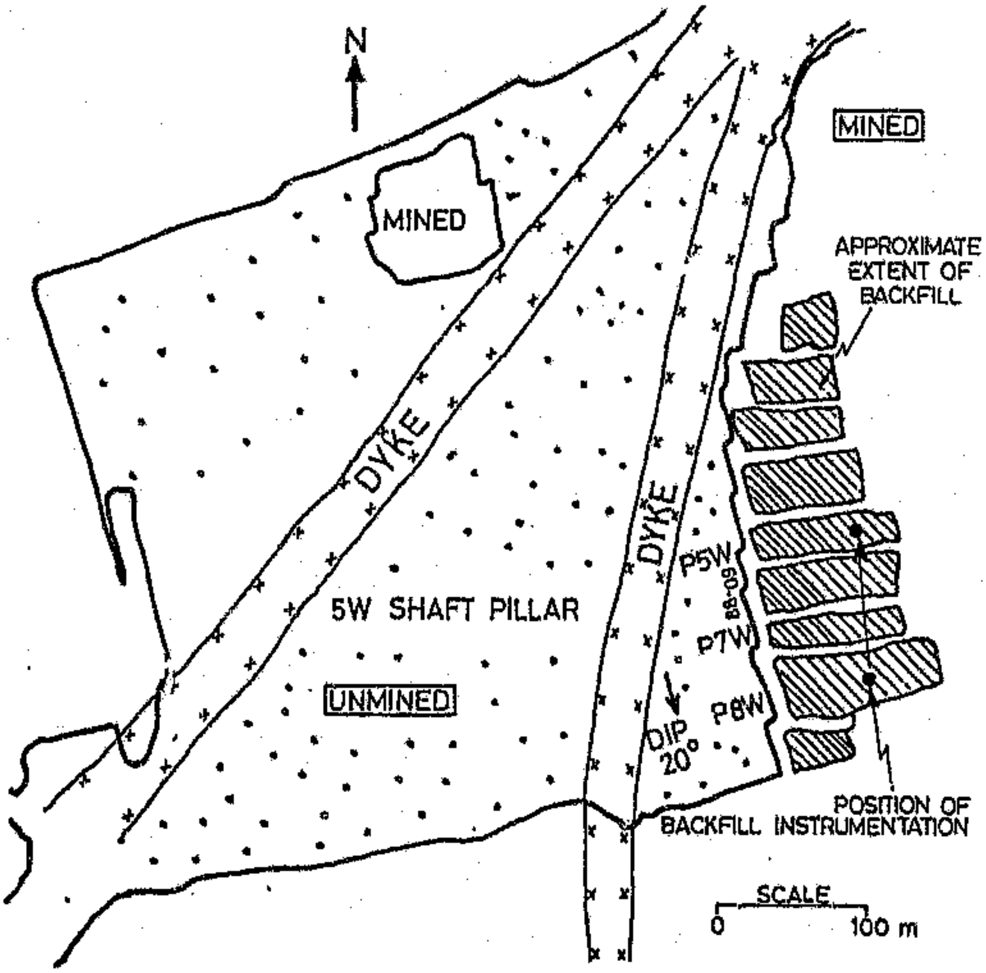

Figure 3.7 Plan of the 5 West Shaft Pillar with extraction and backfilling taking place on the eastern side. The positions of the instrumentation are also shown.

In order to record the closures adjacent to the backfill bags or paddocks being monitored with stress and closure instrumentation, closure ride stations were installed immediately up dip and down dip of the backfill.

The location of the underground instrumentation site in the 28-24 backfilled Carbon Leader stope close to the Number 3 Sub-shaft is shown in Figure 3.9. The dip of the reef is approximately

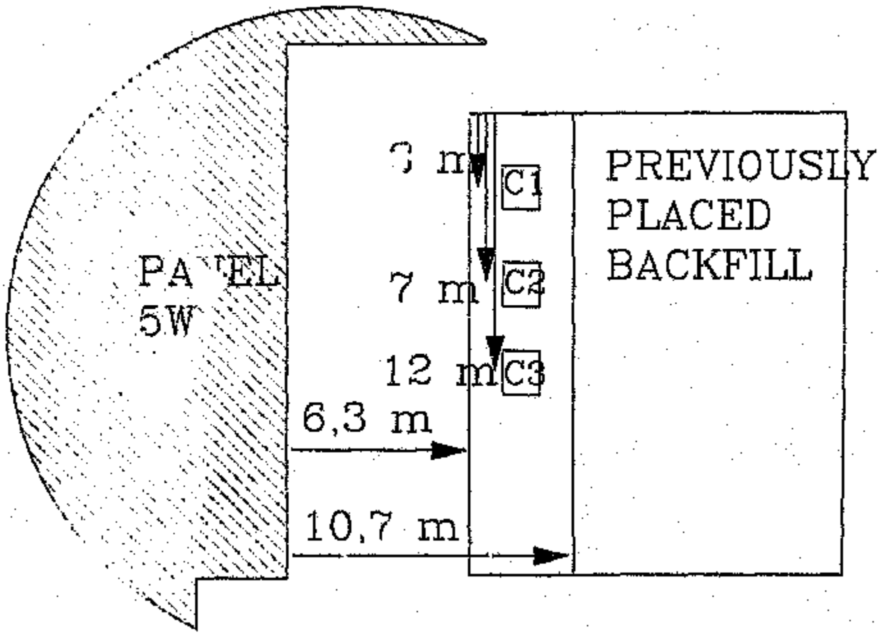

Figure ? · ;ayout of instruments in panel 5 West, 5 ;t Shaft Pillar

22° and the depth of mining in the vicinity of the stope is about 2000 m. The location of the backfill instrumentation and the extent of backfilling are illustrated in Figure 3.9 The mining and associated backfilling which took place was adjacent to a normally faulted dyke which traverses the mine property from north east to south west and passes through the 3 Sub-shaft pillar. Extraction of the reef on the west side of the dyke was completed before mining on the east side of the fault had begun in 1986. Dewatered tailings backfill with a porosity of 44 percent was used in these stopes. Before the start of mining in 1986, no backfill had been placed in this area of the mine.

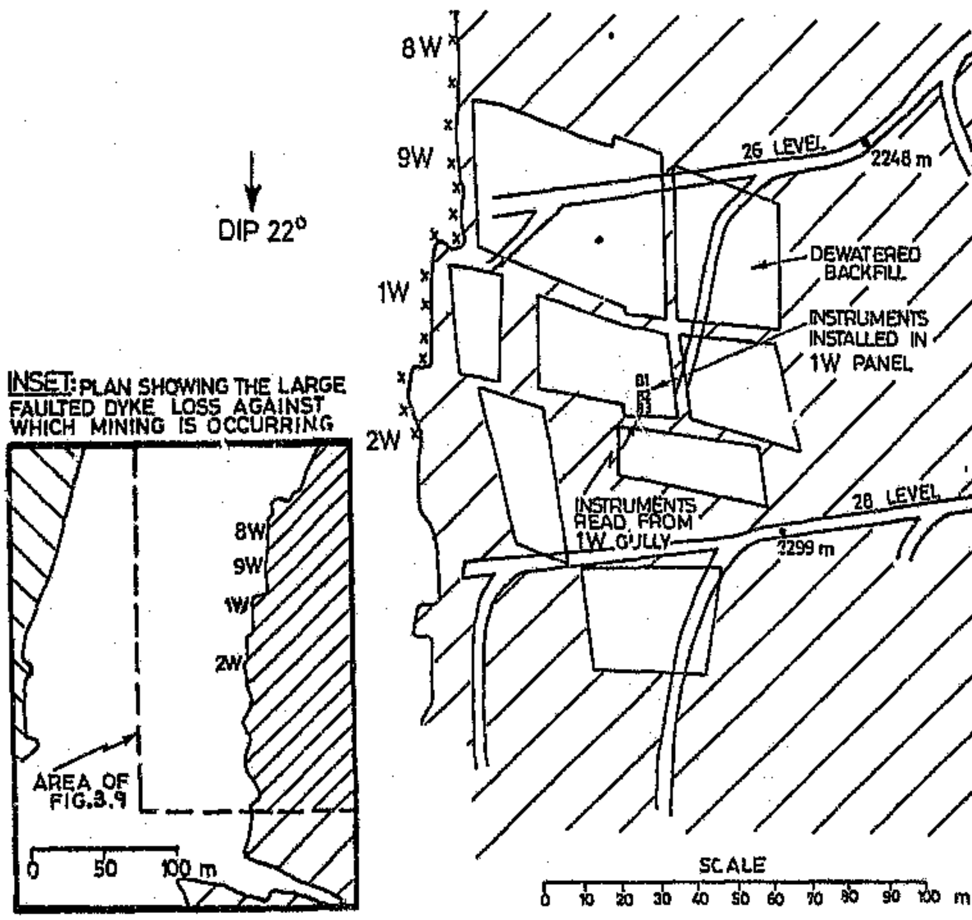

Figure 3.9 General layout of backfill stope at 3 Sub-Shaft

Three triaxial hydraulic stress meters for measuring stresses in three mutually perpendicular directions were installed in a 4 m wide and 22 m long dip paddock in panel 1 West (Figure 3.10). A Glötzl stress cell was positioned close to the B1 triaxial measuring station and a mechanical closure meter was placed next to each of the stress measuring points. Closure ride stations were also installed immediately adjacent to the backfill on the edges of the gullies.

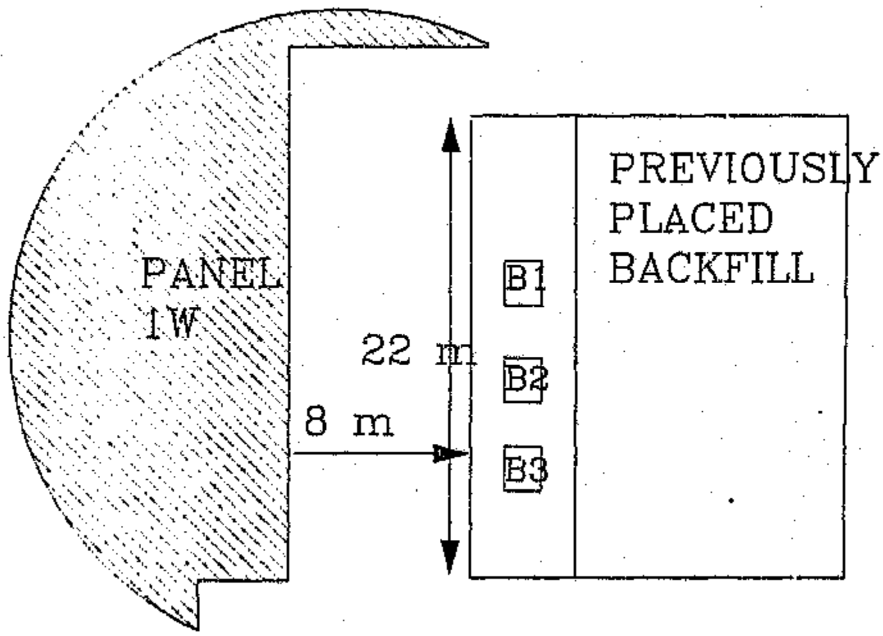

Figure 3.10 Layout of instrumentation in panel 1 West at 3 Sub-Shaft

3.1.2.2 Classified Tailings Backfill

The site west of Number 2 Shaft, where classified tailings with a porosity of 46 percent were used to extract a water barrier pillar, is shown in Figure 3.11. The depth of mining was 1400 m and the dip of the strata in this section of the mine is 25°. Four panels were laid out to extract the highly stressed pillar safely and effectively. Figure 3.12 shows 14-14 Carbon Leader stope and 3 West panel in which three triaxial stress meters and three mechanical closure meters were placed. Up dip of the instrumented bag a closure ride station was installed.

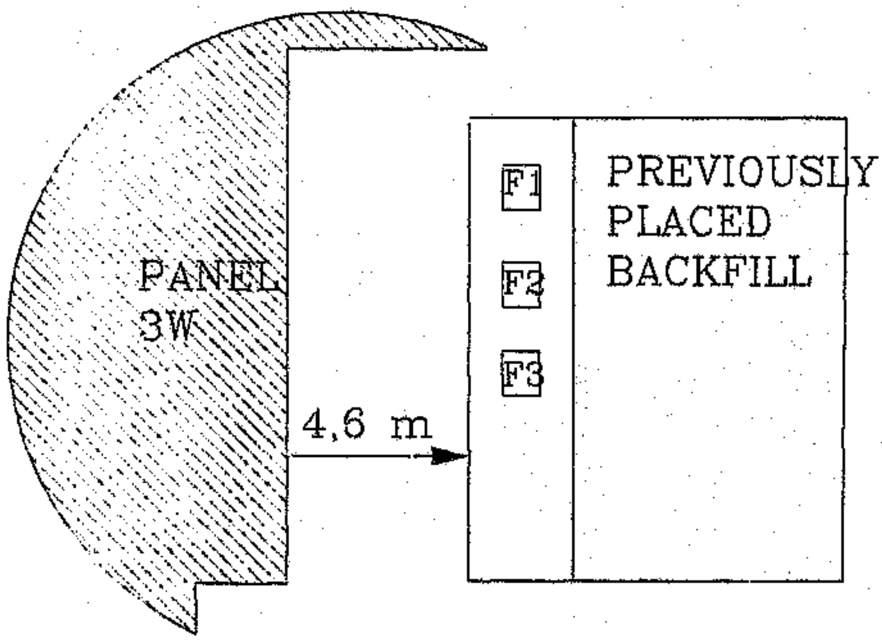

Figure 3.11 Backfill instrumentation layout at No. 2 Shaft, 14-14 stope

4 RESULTS FROM UNDERGROUND FIELD SITES

The underground monitoring experiment undertaken by COMRO has resulted in a large data base of information related to the behaviour of backfill. The correct interpretation of this data is essential in obtaining a comprehesive understanding of the overall performance of different types of backfill.

Before any closure or stress profiles can be established across a backfill rib, the relationships between stress and strain, and stress and time, have to be determined at individual stations. The information derived from the various stations within one bag are combined to give the three dimensional performance of the particular backfill examined. Appendix A contains data files from all the stations.

Conventional timber support is able to control the inelastic closure of the stope to some degree but has minimal influence on the elastic convergence of the rock mass surrounding the stope. Backfill, however, has the ability to act as a regional support if sufficient continuous material is placed underground to provide confinement of the backfill. The presence of the backfill tends to restrict the inelastic portion of closure once even moderate stresses are built up in the backfill. The irresistable elastic closure accounts for most of the closure measured in backfilled stopes. However, the closure throughout a backfilled stope is not expected to be uniform, especially comparing closures at gully positions with closure at the edge of the backfill and at the centre of a backfilled rib. Hence the importance of obtaining closures and strains at different points in the backfill.

4.1 Stress-time relationships

It is important to consider the performance of backfills in relation to time, particularly the ability of a particular backfill type to carry load. An example of the measured stress-time relationship for each of the three types of backfill considered in this dissertation are discussed below.

4.1.1 Comminuted Waste Backfill

Station M3 from Site M has been used to demonstrate the build up in stress with time in confined comminuted backfill. Figure 4.1 shows the stress measurements from four stress cells. Two vertical stresses and a dip and a strike stress were measured at Station M3. The second vertical stress measurement was obtained from a stress cell which was installed to record the maximum stress during rockburst activity. The two vertical stress measurements are similar up to 18 MPa at about 75 days after installation when the maximum stress cell failed. During this time there was no seismic activity in the immediate vicinity of the instrumentation stope. The dip and strike stresses showed good agreement until 10 MPa, about 70 days after installation, when the strike stresses increased more rapidly than the dip stresses. The dip stress cell ceased to work four days after the change in the strike and dip measurements were noted and the change may be related to the dip stress cell beginning to fail.

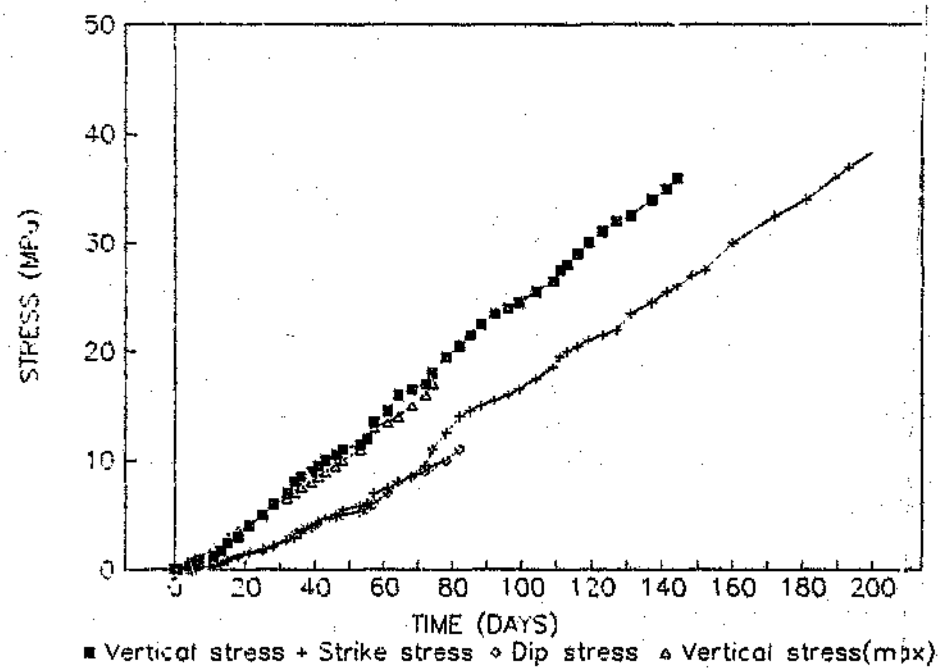

Figure 4.1 Stress-time plot for Station M3

All four curves in Figure 4.1 suggest that the stresses increase in the backfill with time. It is not obvious from the figure when the face was advanced or when it remained static. In the situation monitored, it seems that there was a continual increase in stress in the backfill with time.

The relationship of the stress measured in the backfill to the face advance is recorded for Station M3 in Figure 4.2. It is clear from this figure that although there were some days when the face did not advance, the vertical, dip and strike stresses continued to increase. The rate of face advance ceased and decreased at 19 m and between 40 and 55 m of face advance respectively, but the stresses increased at the same rate. After 20 m of face advance the stress curves are steeper than at their initial stagess. This suggests the strong presence or even predominance of time dependent loading of the backfill in addition to the elastic response of the rock, related to the mining. The loading of the backfill is due to the closure of the opening created by mining.

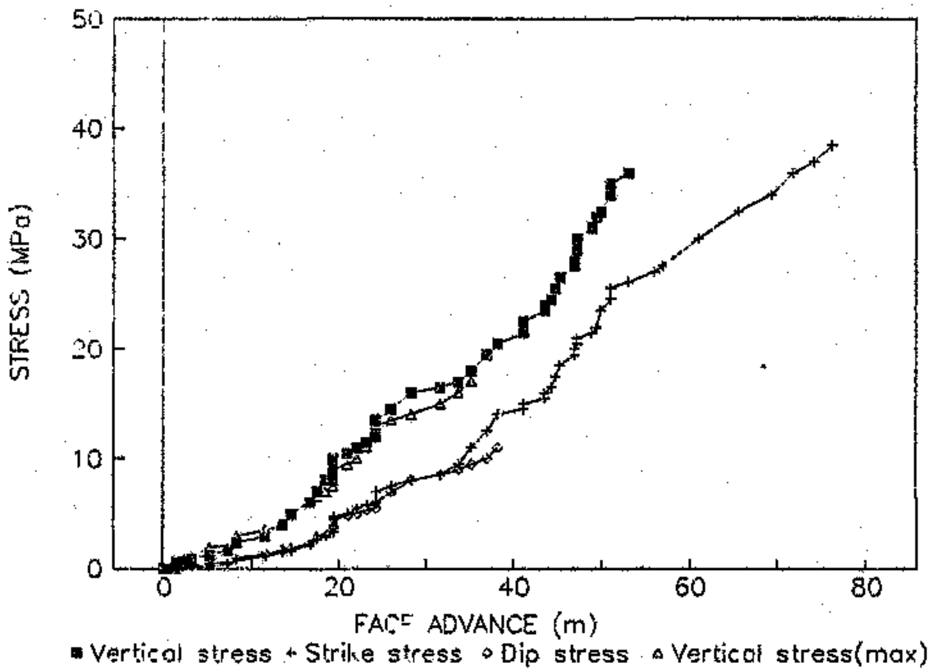

Figure 4.2 Stresses measured at Station M3 plotted against face advances

In the case of the vertical stresses shown in Figure 4.1, the increase in stress with time is almost linear for a period of 140 days; this supports the argument of time dependent closure, related not so much to the overall geometry and changes in this, but to the persistant closure of the approximately 1 m wide slot which is created with mining. The rate of stress increase in the dip and strike directions is less linear than the vertical stress increase. However, the strike stress which was monitored for a longer period than the dip stress showed increased linear behaviour with time. This is possibly due to the backfill becoming more dense with time and thus demonstrating a more elastic Poissons effect as stresses are applied vertically.

Station Q was installed close to the edge of a comminuted waste backfill bag. The stress-time graph in Figure 4.3 shows the behaviour of the comminuted waste in less confined conditions than Station M3. At 40 days, approximately 4 MPa vertical stress was measured at Site Q compared with 10 MPa at Station M3. It is clear from the graph that stresses measured in all three orthogonal directions increased steadily with time. There is a distinct change in the slopes of the vertical and dip stress curves at approximately 4 MPa. The strike stress curve shows a change at 4 MPa; this appears however, to be associated with some general change in conditions at 90 days rather than with the actual 4 MPa stress because the vertical and dip stresses also show a change at this point. The curves do not display any sections which are horizontal although the stress-face advance graph (Figure 4.4) shows that the face was static at 26 m. Figure 4.4 shows that, although the face was stationary, the stresses increased by 5 MPa in vertical and dip directions and by 2 MPa in the strike direction.

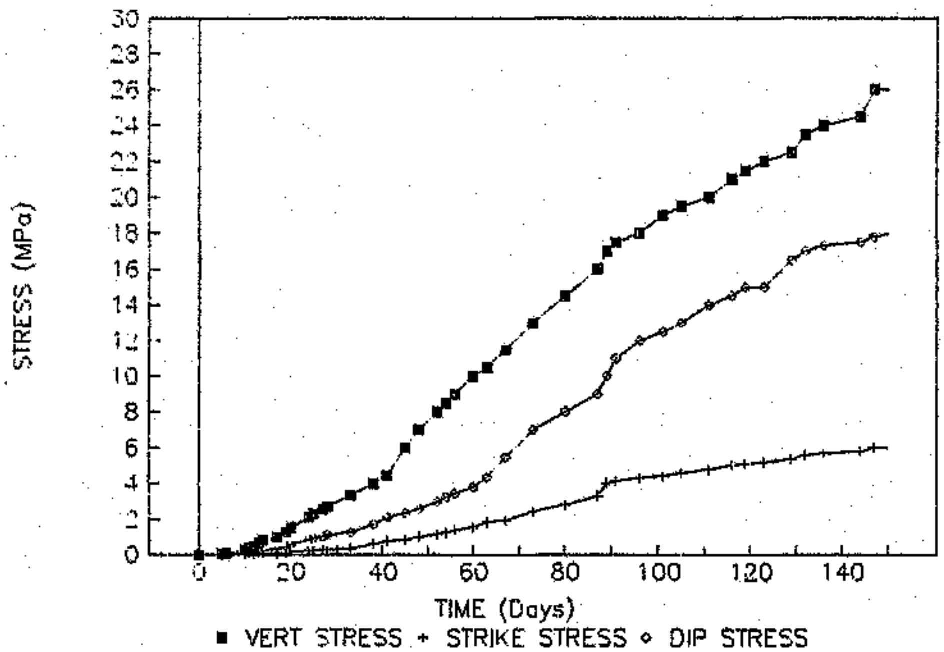

Figure 4.3 Stresses plotted against time for Site Q. The curves are linear except for variations in slope at 4 MPa and at 90 days

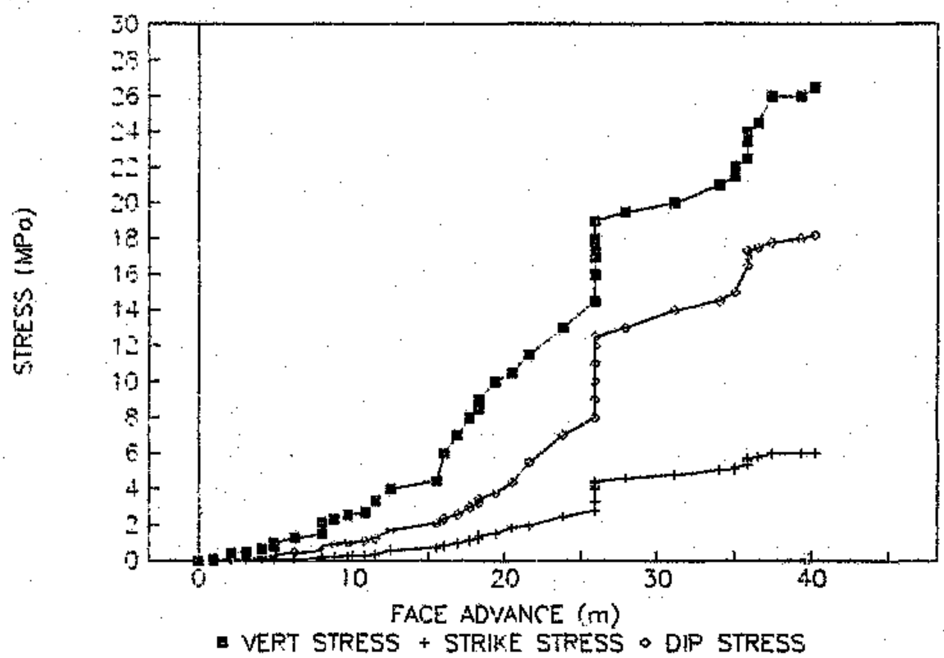

Figure 4.4 Stresses plotted against face advance for Site Q. At approximately 26 m of face advance the faces temporarily remained stationary but stresses continued to increase

4.1.2 Classified tailings backfill

Site P at 85 level Western Deep Levels has been selected to demonstrate the stress-time relationship in classified tailings. Stations P1 and P2 exhibit almost straight lines in their stress-time behaviour (Figure 4.5), with no horizontal sections on their curves to indicate possible static face positions. The strike and dip stresses increase at a slower rate than the vertical stresses, but show an increase in their rate at about 170 days at Station P1, which then returns to previous levels. Initially, up until about 50 days, all three stations show no increase in stress with time (Figure 4.5). All three stations' stresses increase sharply at approximately 375 days, probably due to seismicity, with the vertical stress measured at P3 increasing at a similar rate to the horizontal stresses at Stations P1 and P2. Station P3 shows a horizontal section to its curve from 100 days, which would appear to be attributable to the face stopping. However, examination of the stress-face advance graph (Figure 4.6) shows that the face was advancing continually. It is therefore reasonable to surmise that the stress meter was sticking or that some arching effect existed around the stress cell which was broken with further stress increases.

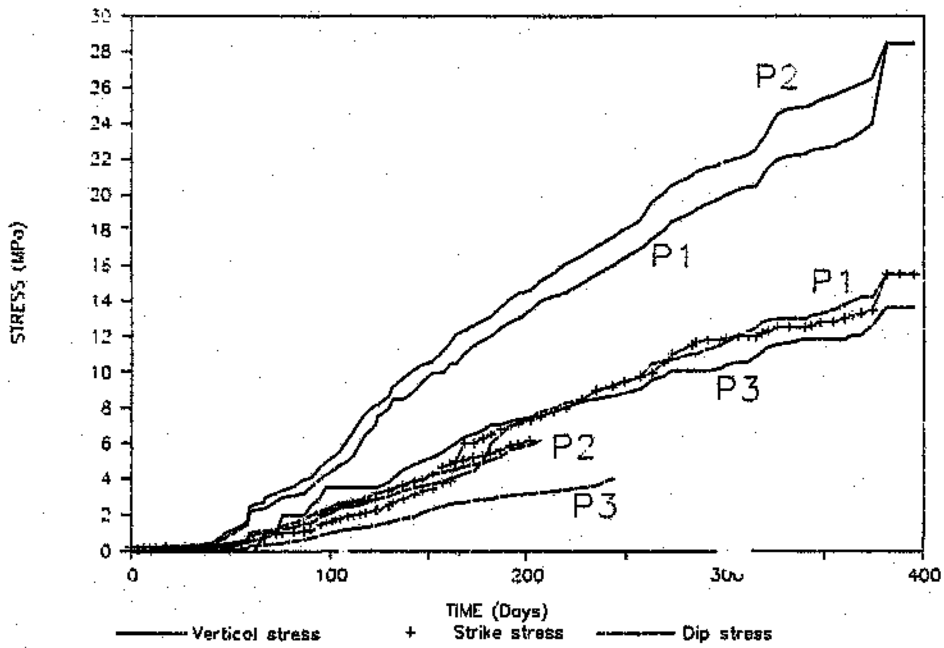

Figure 4.5 Composite plot of stress versus time for Stations P1, P2 and P3. Stresses measured in the three orthogonal directions are shown for the stations where these were available

Site R was installed close to the edge of a classified tailing backfill bag to establish the performance of this backfill type under unconfined conditions. The stress-time plots from the one station, Station R (Figure 4.7) show no horizontal sections to their curves which would suggest that the faces advanced between each measurement of stress. However, an examination of the stress-distance to face plot (Figure 4.8) shows that there were periods when the distance from instruments to the face remained constant, but the stresses continued to increase.

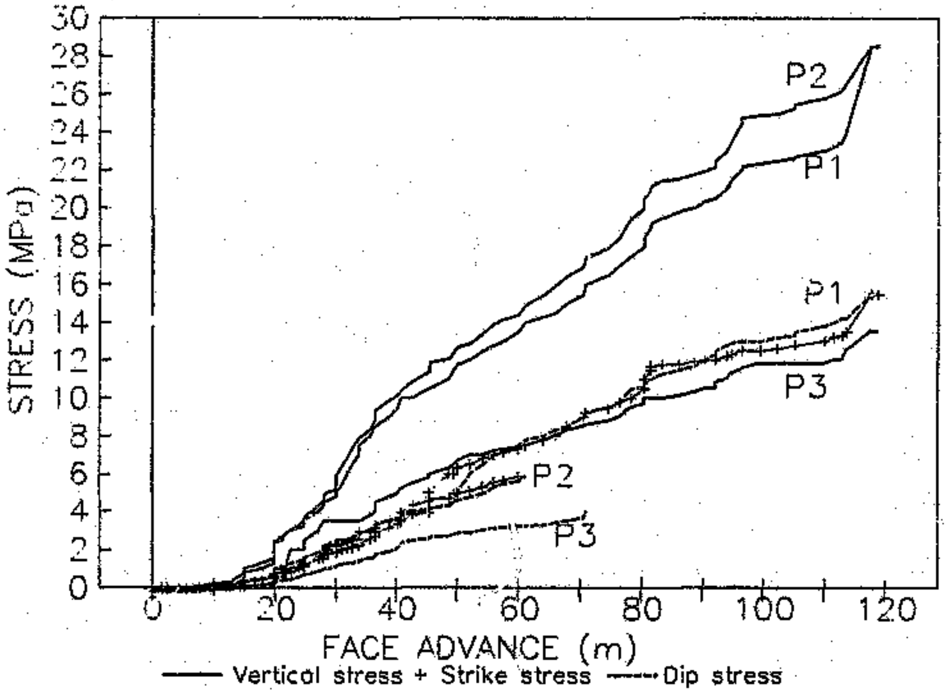

Figure 4.6 Composite plot of stress versus face advance for Station P1, P2 and P3. Stresses in the dip and strike directions are also shown when these were available

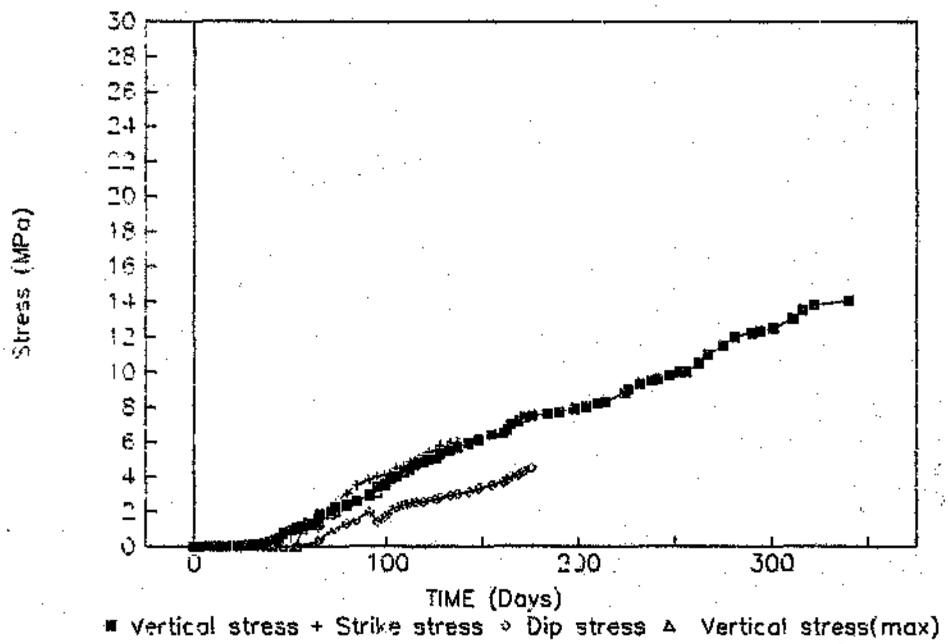

Figure 4.7 Stress-time graph for Site R showing the build-up in stress in three orthogonal directions with time

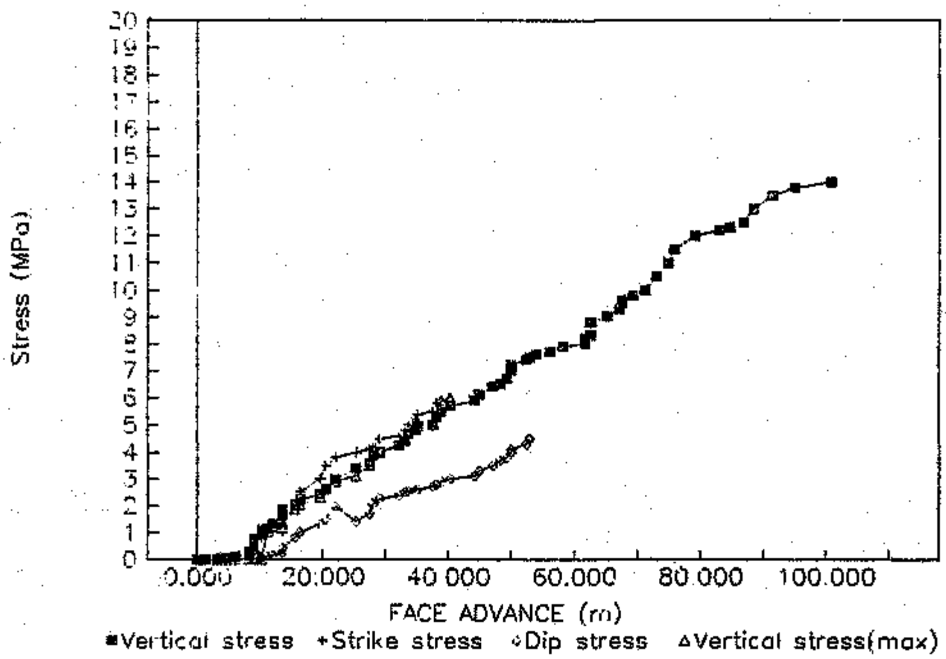

Figure 4.8 Stress-face advance graph for Site R showing the change in stress in three orthogonal directions as the face advanced

4.1.3 Dewatered tailings backfill

Site C located in a dewatered tailings backfill stope at West Driefontein Gold Mine is used as an example of the stress generation with time in this backfill type. Site C is comprised of three stations with three orthogonally positioned stress meters at each station. A number of stress meters failed at low stress levels but sufficient instrumentation survived to draw some conclusions as to the stress-time relationship in dewatered tailings backfills.

At all three stations, the stresses increase steadily with time, usually at a slower rate in the time before approximately 150 days and at faster rates after approximately 200 days (Figure 4.9). The dip and strike stresses built up more slowly with time than did the vertical stress. All the curves are almost linear with no indication of horizontal sections or even slowing down of the rate of closure during periods when the face advance was static. Inspection of the stress-face advance graphs also shows increases in stress when the face was static and particularly in the cases of the vertical stresses. It is expected that mining in adjacent panels would result in continued closure but at a slower rate. The stress plotted against face advance increased linearly with an increased rate of stress generation after 18-25 m of face advance (Figure 4.10).

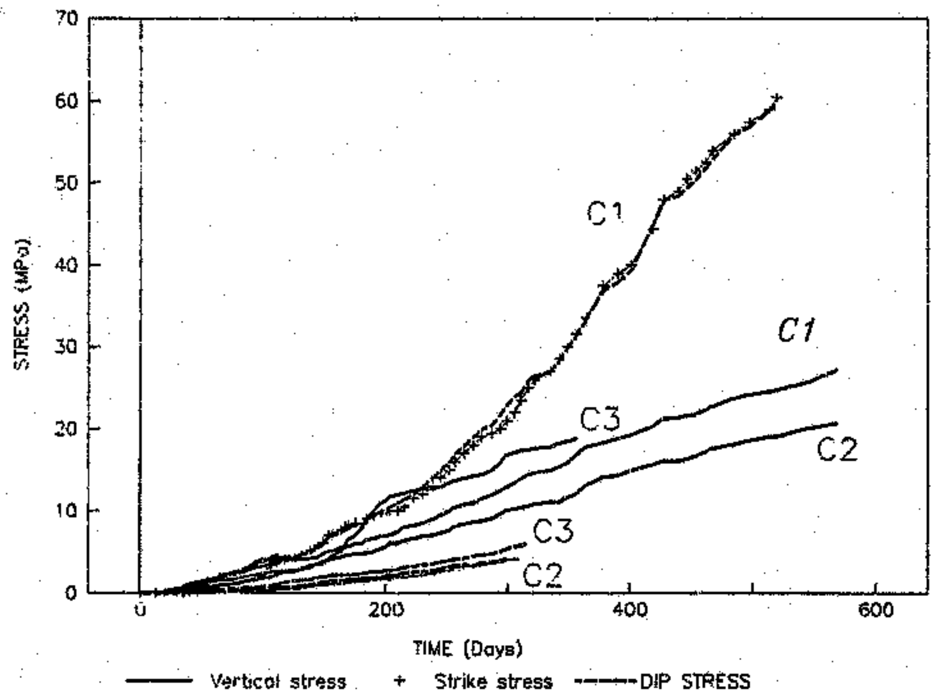

Figure 4.9 Stress-time graphs of Station C1, C2 and C3

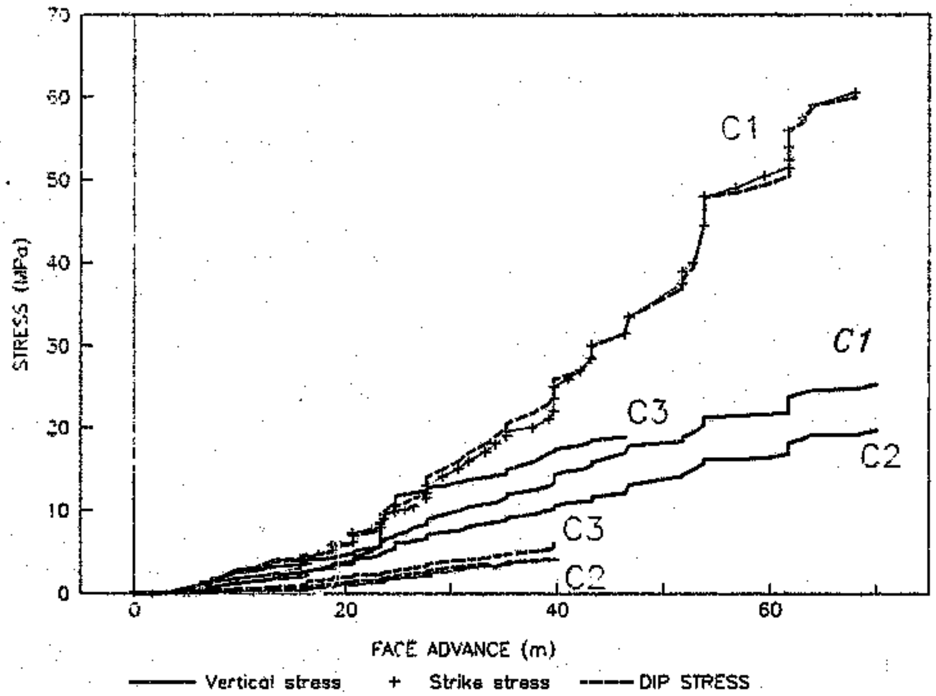

Figure 4.10 Stress-face advance for Site C

4.2 Stress-strain relationships at a point

The stress which is developed due to loading of the backfill at a specific point is dependent on the quality of the backfill, the height of the backfill, which is usually close to the stoping width, and the degree of confinement of the backfill. In the section below, examples of the stress-strain performance of each type of backfill will be presented. For comminuted and classified backfill, an example of confined and unconfined conditions will be given and discussed. An unconfined station was not installed in dewatered backfill. In a subsequent section this information will be combined to arrive at an understanding of the three dimensional stress-strain behaviour of each backfill type.

4.2.1 Comminuted Waste Backfill

Station M3 of Site M has been selected as the confined comminuted station because of its central position in the backfill. Figure 4.11 is a graph of the relationship between the stresses and vertical strain measured in the backfill at Station M3. The vertical stress is consistently higher than the stresses measured parallel to dip and strike respectively, with these stresses being very similar up to about 17 % strain. At approximately 18 % strain the dip stress cell ceased to work, while the vertical stress cell stopped working at 36 MPa and 20 % strain. The strike stress cell worked until 62 MPa at approximately 21.6 % strain. The strain for all three stresses was calculated using the same closure-meter installed next to the stress cells. The three curves show the same characteristic parabolic curve, with a fairly flat section on all until approximately 11 % and steepening beyond this value. The flattening of the vertical and strike stress curves between 18 % and 19 % strain, showing an apparent softening of the backfill, may be due to redistribution of stress in the backfill or as a result of the closure-meter being displaced.

The similar behaviour of the dip and strike stresses with increases in vertical stresses as a result of vertical loading of the backfill is confirmation of the confined nature of the backfill

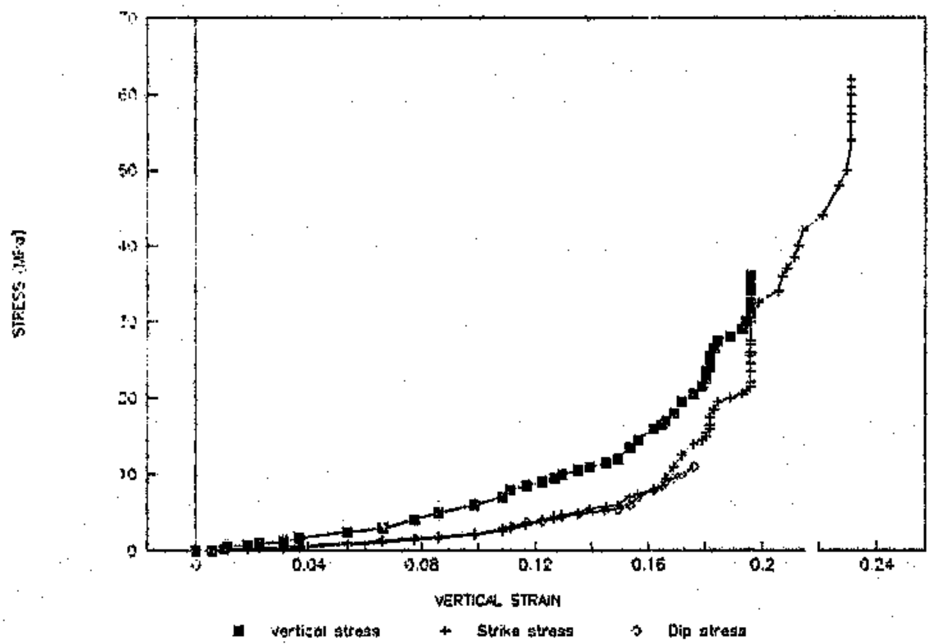

Figure 4.11 Stress-strain relationship for Station M3 at Site M

at the position of Station M3. It is unlikely that the increase in stress in the vertical direction would have been so rapid or that the dip and strike stresses would have been so consistent if the backfill had not been confined. The vertical cell registered stress from 1 % strain while the dip and strike cells indicated stress from about 2 % strain. The measurement of stresses at low strains indicates that the backfill was well placed, probably in contact with the hangingwall; that the backfill material did not shrink after placement; and that the position at which the measuring station was located was confined.

Station Q has been used as an example of the unconfined behaviour of comminuted waste. The station was installed 1 m from the down-dip side of a backfill bag. Figure 4.12 shows the vertical, strike and dip stresses recorded at this station. Also on the graph is the 27 % porosity curve. Usually a confined sample's vertical stress should follow the 27 % porosity curve as this is the placed porosity of comminuted waste. However, the vertical stress of Station Q clearly does not follow the 27 % porosity curve, as expected for unconfined conditions, but is closer to a 32 % porosity curve. Whereas the stresses in the confined situation discussed above for Site M picked up rapidly from 1 % strain, Station Q began registering vertical stresses only at 7 % strain. The dip and strike stresses were, as expected, always lower than the vertical stress but were also different from each other. Not expected was the strike stress being consistently lower than the dip stress.The minimum confinement was expected in the dip direction towards the edge of the bag, but this was not evident from the results which showed higher stresses in the backfill in the dip direction than in the strike direction. Immediately downdip of the instrumented bag a pack was installed which may have supplied more restraint than the backfill bags behind and in front of the bag in which Station Q was installed. Between adjacent backfill bags there are often small gaps which the deforming backfill will fill and thus stresses in this direction may pick up more slowly, as in the case of Station Q.

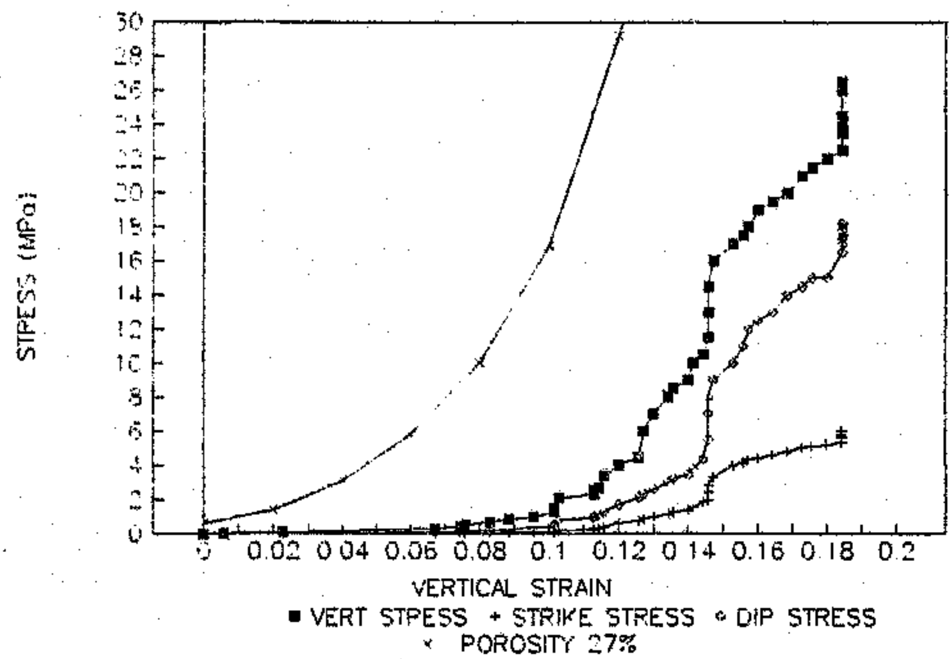

Figure 4.12 Stress-strain curves from stress cells installed at Site Q which is close to the edge of the backfill with the 27 % porosity curve

4.2.2 Classified tailings backfill

Site P at Western Deep Levels Gold Mine, with three stations installed in the fill, is used to illustrate the stress-strain behaviour of classified backfill. Station P1, which is closest to the edge of the backfill, has a vertical stress-strain profile similar to the vertical stress curve of 47 % porosity classified backfill tested in confined conditions (Figure 4.13), suggesting that the backfill material at the measuring position was in confinement. The initial stages of the in situ stress-strain curve do not match the laboratory curve. Figure 4.14, which shows all three stations' vertical stress curves, shows that Station P2 has a similar performance to P1 but that P3 experienced lower stresses. In the case of all three stations, the stresses in the dip and strike directions were lower than the vertical stresses.

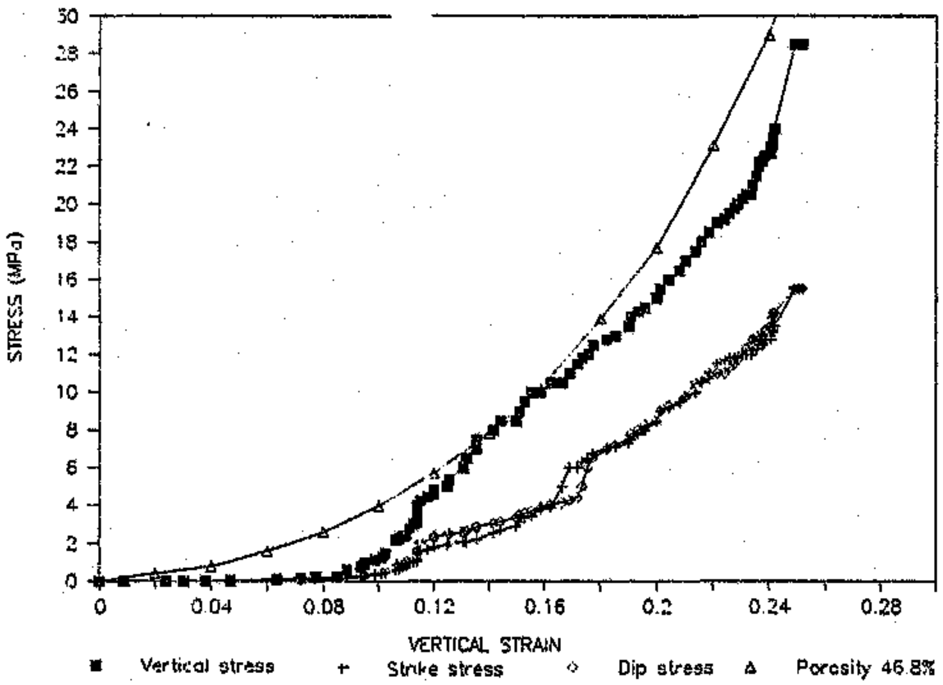

Figure 4.13 Station P1 stress-strain profile and the 47 % porosity curve obtained from a confined laboratory test on similar material

A backfill instrumentation station (Station R) was installed close to the edge of the classified backfill to measure the performance of the backfill at its edges. The stress-strain curves are shown in Figure 4.15 with the expected vertical

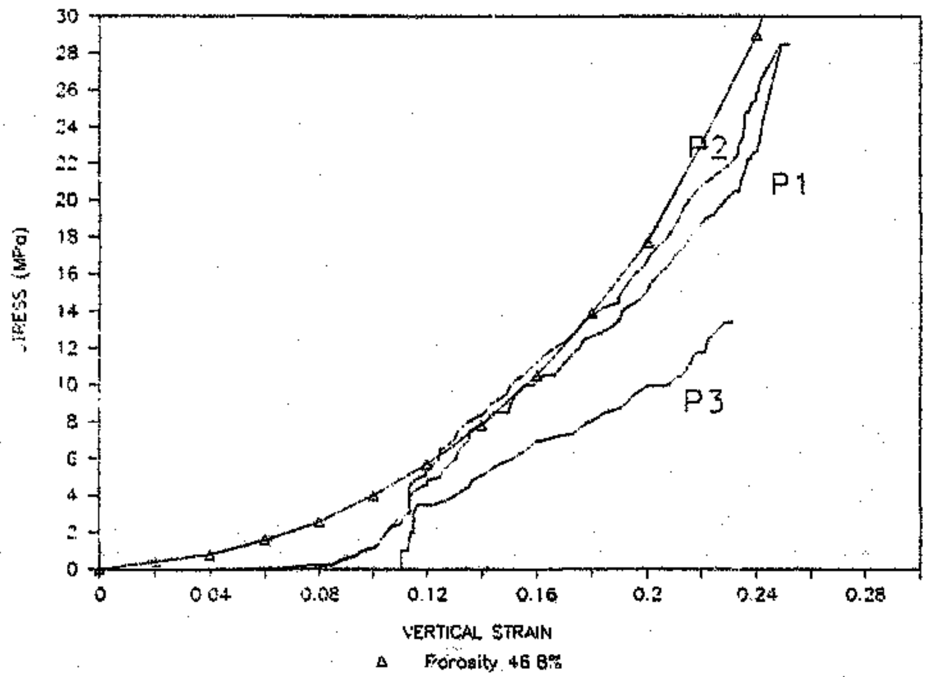

Figure 4.14 Stress-strain curves for Station P1, P2 and P3. Stations P1 and P2 have similar performances but Station P3 exhibits lower stresses at similar strains

stress-strain behaviour for 47 % porosity backfill in confined conditions. All the measured curves are well below the porosity curve for confined conditions. The two vertical stresses and the strike stress follow a similar path but the dip stress path is lower. The strike stress even shows slightly higher readings than the vertical stress cells. This may be due to inaccuracies in the instruments or in reading them. The fact that the strike stress registers similar values to the vertical stress is due to the low confinement in the dip direction at this point in the backfill. The lower stresses in the dip direction are indicative of this low confinement.

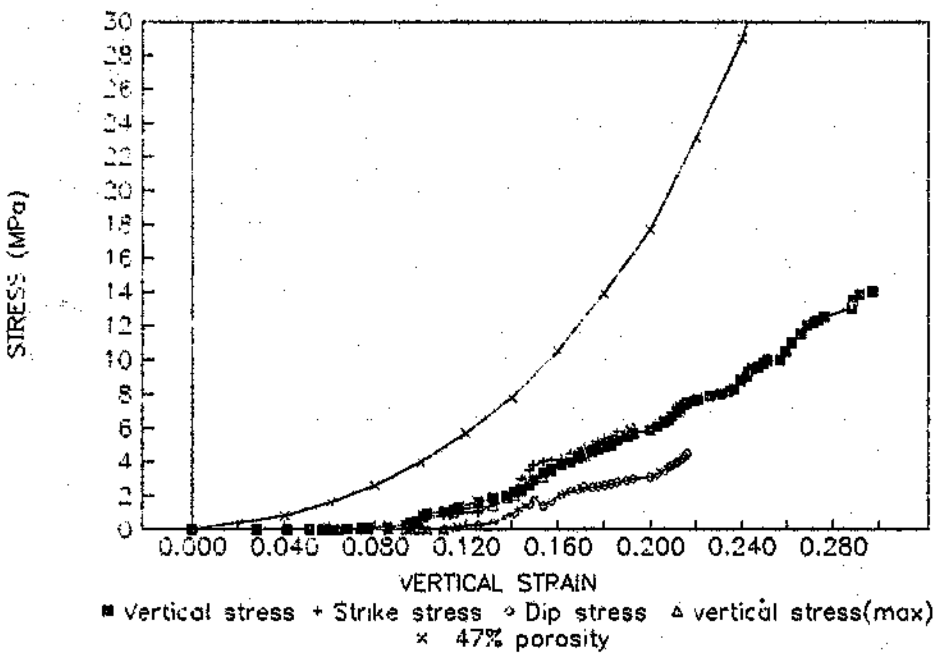

Figure 4.15 Stress-strain performance recorded at Station R close to the edge of a backfill rib with the 47 % porosity curve

4.2.3 Dewatered tailings backfill

At Site C, 5 Shaft West Driefontein Gold Mine, the stress meter for measuring the vertical stress at Station C1 failed at low stresses. The dip and strike stress cells at this station yielded higher than expected values which suggested that the stress meters may have rotated in the backfill during installation and that the stress being measured may have been close to the vertical stress (Figure 4.16). The stoping width in the vicinity of Station C1 was narrower than the remainder of the stope at the time of the installation of the instrumentation. Almost total apparent closure occurred in this area with time and this may have significantly influenced the local stress regime in the backfill. At 24 % strain, the stress measured by the dip and strike stress meters at Station C1 was approximately 20 MPa. At Stations C2 and C3 the vertical stress cells continued to function to 24 %, at which strain the vertical stress recorded at C2 and C3 were 20 MPa and 30 MPa respectively.

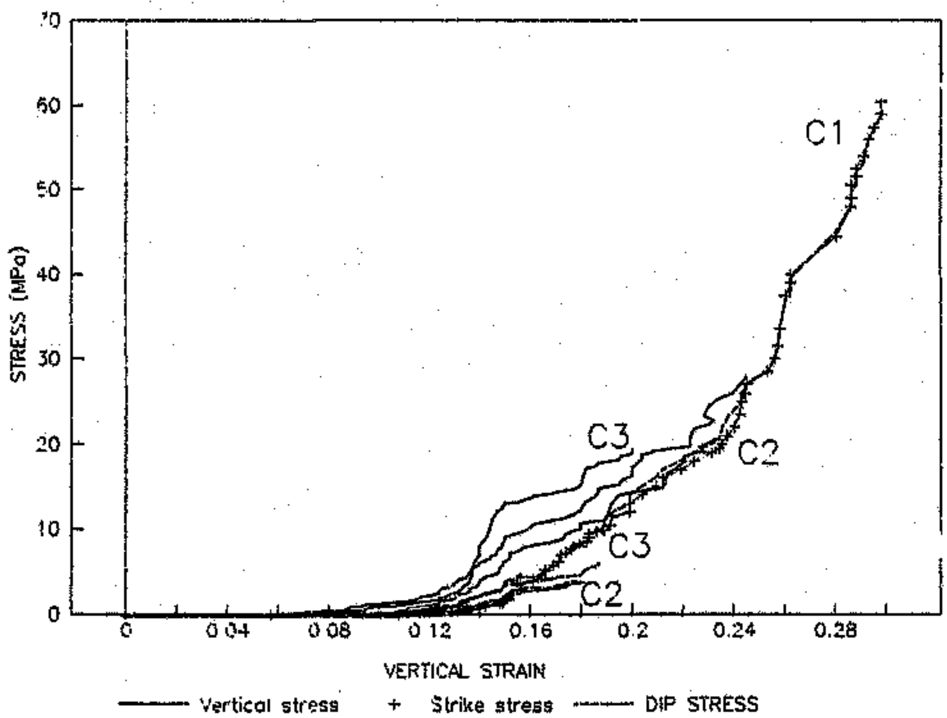

Figure 4.16 Stress-strain profiles from Site C. The profiles from the three station C1, C2 and C3 are shown on the one graph

4.3 Closure and strain relationship across backfill ribs

In a backfilled stope, the stope will experience differential closures due to the variable stoping width and stiffness of the backfill which is related to the height of backfill placed. Therefore, when comparing the stresses developed in backfill, the measured closures are normalised by converting them into strains.

In the Carbon Leader stopes, particularly, the stoping width is extemely uniform and thus the closure and strain profiles show similar patterns.

4.3.1 Comminuted Waste Backfill

Site M was used to demonstrate the closure across a dip section of a backfill rib in comminuted waste backfill. Stations M1, M2 and M3 were installed on a dip section, in one bag, and Figure 4.17 combines the closure data collected from the three stations. The closure results are summarised in Table 6.1. As anticipated, the closure at the station nearest the edge of the backfill, M1, initially showed greater closure than those deeper in the backfill due to less confinement towards the edge of the bag. If the backfill is unconfined and able to dilate into the stope then the backfill is effectively less stiff in these areas.

For the first 10 days after the installation, Station M1 experienced twice as much closure as Station M2. This station in turn experienced about twice as much closure as the station at the middle of the bag, M3, over the same period of time. After

10 days, the closure rate at all three stations relative to one another remained the same. This represents the period in which fairly low stresses were being built up in the backfill. The stress at M1 was 8 MPa, at M2 it was 3 MPa and at M3 it was 5 MPa. The closure and thus the strain at M1 were considerably higher than at M2 and greater still than at M3; therefore the stresses at M1 are expected to be higher. The stress at M2 was lower than at M3 although the closure and therefore also the strain are greater at this position. The backfill must therefore have been less confined for some reason at Station M2. It may have been that the adjacent backfill bag/s were not placed in close contact with the instrumentation bag or that the backfill in the vicinity of the measuring point in question was less dense, resulting in more easily deformed backfill.

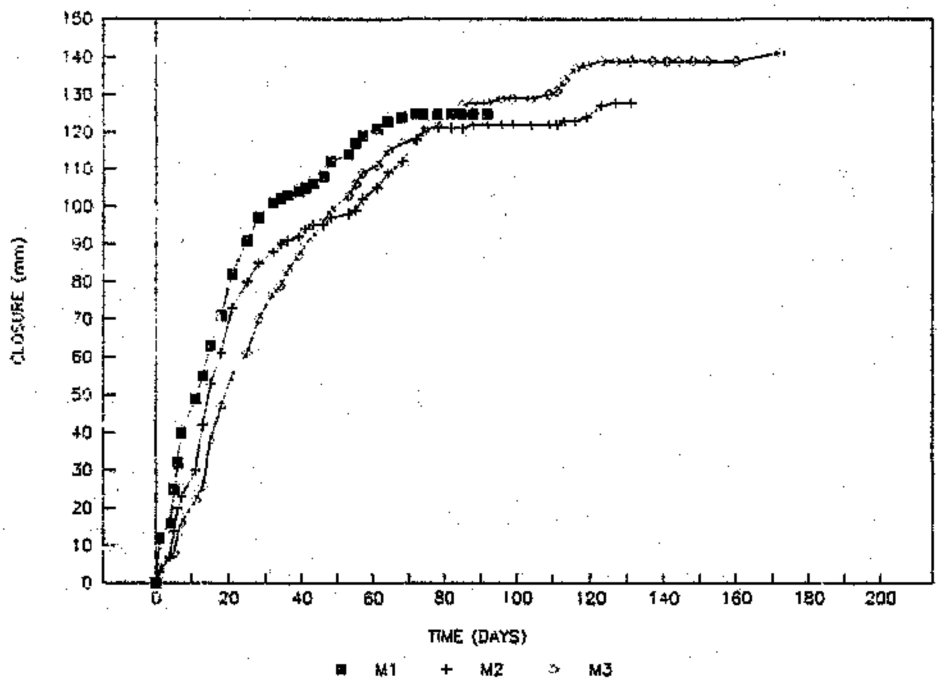

Figure 4.17 Closure profiles measured at Stations M1, M2 and M3. Station M1, closest to the edge of the bag, showed the greatest closure initially as expected at the station with least confinement

After about 26 days the closure rate at all three stations decreased but the stresses rose rapidly. By about 80 days the closure meter of M1 had ceased to record changes and by about 90 days the closure meter at M2 had stopped registering change. In both cases the closure meter had probably reached the limit of its travel. By 70 days, the three stations had experienced very similar closure but, still, the most was being measured at M1. The highest

Table 4.1 Closures recorded at Stations M1, M2 and M3 from the time of installation of the closure instruments

	CLOSURE (mm)		
DAYS AFTER INSTALLATION	STATION M1	STATION M2	STATION M3
10	50	30	20
20	80	65	50
40	105	92	90
60	120	105	112
80	125	120	121
100	125	123	130

stress was recorded at M3 with a stress of 28 MPa. At that same time M1 recorded 25 MPa and M2 recorded 20 MPa.

The above description of the closures are expected. More closure occurs towards the edges of the backfill initially and during this period there is a high rate of closure through-out the stope. Once significant amounts of closure have occurred, the backfill is able to resist the closure because it has become stiffer and stresses are rapidly generated in the backfill. At this stage the more confined the backfill is, the greater will be the stress recorded in the backfill. Critical at this time is the relationship between confinement and the strain in the backfill. Although M2 was more confined than M1, the latter station had experienced more closure and was experiencing greater strain. Also, as stated above, the situation at Station M2 was suspected to be different from the rest of the bag.

The closure at Site Q at the edge of the backfill recorded 50 mm of closure in the first 10 days (Figure 4.18), similar to Station M1, compared with 30 mm and 25 mm in the same time period at Stations M2 an M3 respectively, which were deeper into the backfill.

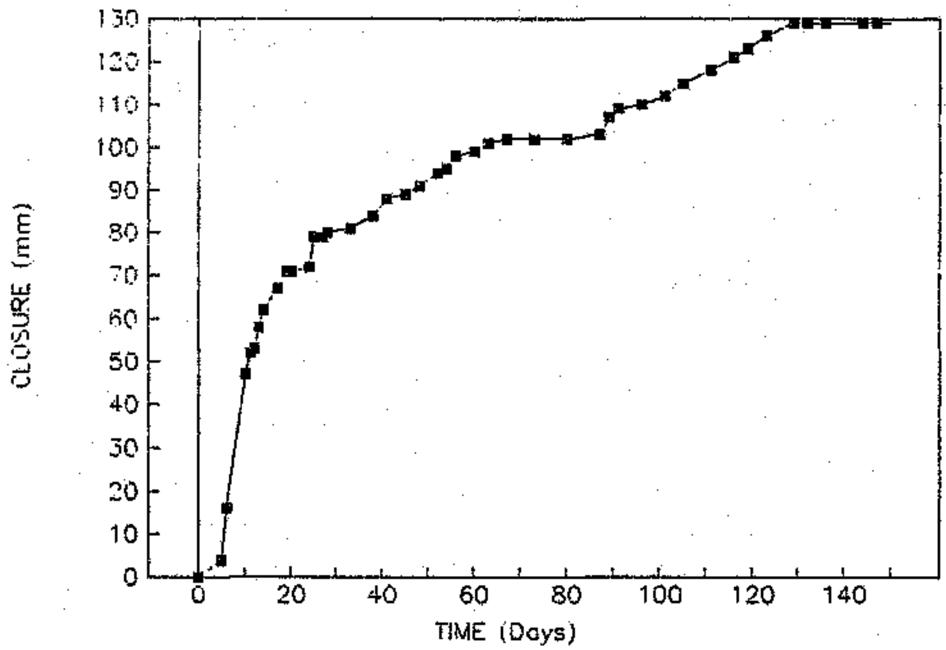

Figure 4.18 Closure profile from Site Q which was installed close to the edge of the backfill rib. Initially this site experienced rapid closure compared with Stations M2 and M3 deeper into the backfill.

4.3.2 Classified tailings backfill

Site P had three stations at which closures were measured (Figure 4.19). All three stations experienced similar closures for the first 130 days. After this, Station P2 appeared to have reached a plateau and then ceased to work. It is significant that P1 and P3 show such good agreement and it is probable that P2, situated between these two stations, would have reflected similar closure if the closure meter had continued to operate. The results suggest that the stations were deep enough into the backfill to be in confined backfill which would have been of a simlar stiffness and thus would have experienced similar closure.

Station R was positioned very close to the edge of the backfill close to Site P and it is expected that closures close to the edge of a backfill rib will be more rapid than deeper into the backfill. However, this was only true immediately after installation in the case of Station R (Figure 4.20). It may be due to the presence of timber packs very close to the closure station which modified the closure locally. Also, the site of Station R is some distance from Site P and variations in the rock mass are common, so that closures may have been more rapid in the vicinity of Site P.

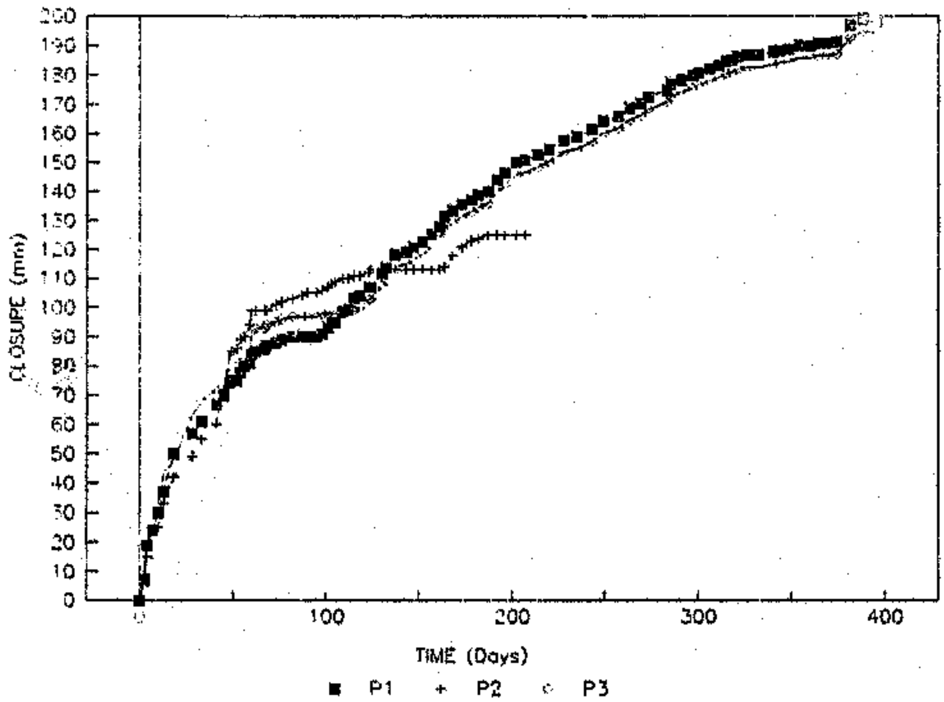

Figure 4.19 Closure profiles for Site P. The three measuring points recorded similar closures until Station P2's closure meter apparently ceased to operate.

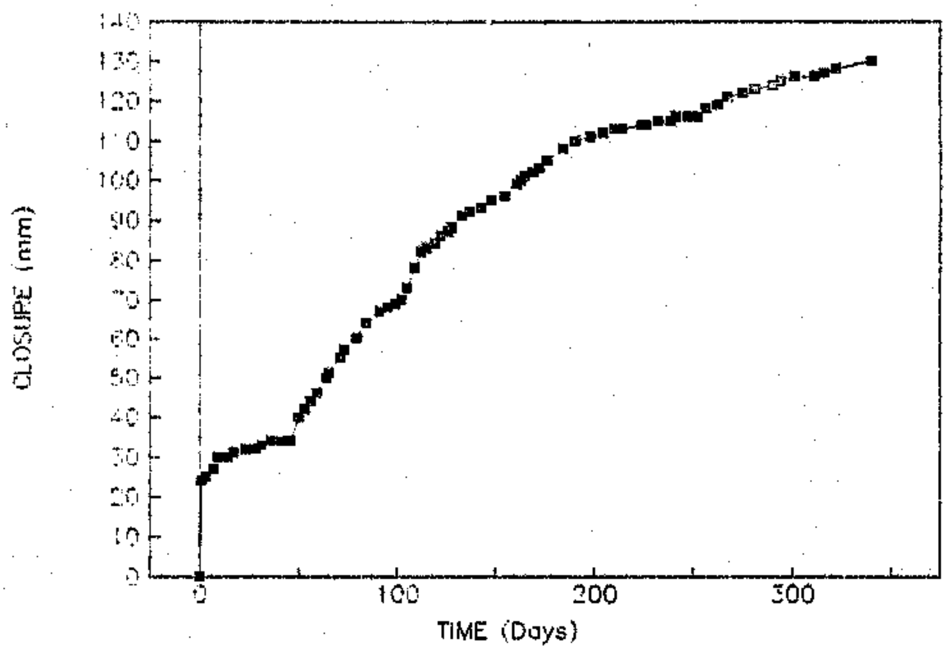

Figure 4.20 Closure profile for Site R close to the edge of the backfill

4.3.3 Dewatered tailings backfill

Site C at West Driefontein Gold Mine had three stations at which closures were measured. Figure 4.21 shows the closures of the three stations against time. Initially, the closure at all three stations was rapid, the steepest being C1 which was closest to the edge of the backfill and the least steep being C3 which was deepest into the backfill. After approximately 50 days, the rate of closure at all three stations began to slow down. At this time stresses acting in the backfill were between 1 and

2 MPa. C1 had a slightly higher rate of closure than C2 and C3 which experienced similar closure rates.

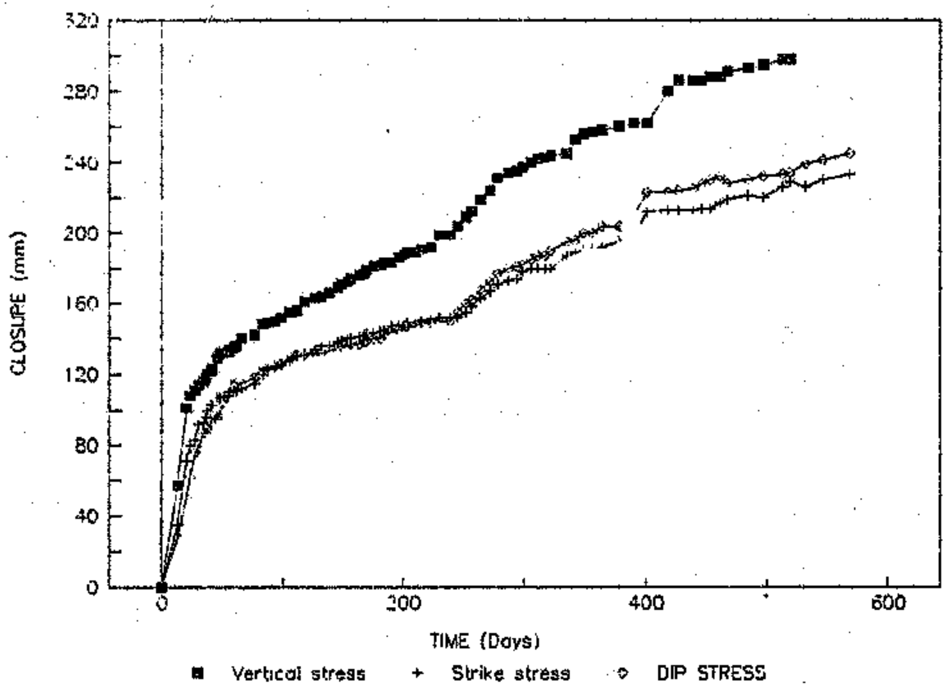

Figure 4.21 Closure profiles from Stations C1, C2 and C3 with time

4.4 Stress relationship across backfill ribs

Two different approaches to plotting the stress profiles across backfill ribs are presented in this dissertation. The first approach is to record the stress which occurs at each station on a specific day and to join these points with a single line. Each of these lines represents the stress profile across half a rib on a specific day. In all the backfill ribs discussed in this dissertation only half the rib was instrumented because of the near symmetry about the centre of a rib as discussed in Chapter 3, "Description of the sites".

The second method is to establish the stress which occurs at each station at a chosen strain and to join these points with a line. Equal strains usually do not occur at the different stations on the same day nor do they occur at equal stresses. This method of normalizing the stresses in terms of strain effectively removes the influe[illegible]iable stoping widths and different closure [illegible] stress profiles which result are simi[illegible]r to those from a laboratory experiment where parallel flat platens compress the backfill. On Figures 4.32 to 4.24, solid lines represent stress profiles on a daily basis and the broken lines represent stress profiles at equal strains.

4.4.1 Comminuted Waste Backfill

Figure 4.22 shows the vertical stresses monitored at Stations N1, N2 and N3 which were installed along a dip section of a backfill bag. The stoping widths at the three stations were 600 mm, 590 mm and 710 mm respectively. Each solid line in the figure represents the daily vertical stress profile across the bag. The broken lines are contours of equal strain and indicate the amount of strain which occurs at a particular stress.

It is clear from Figure 4.22 that the values of daily stress recorded at Station N1 are consistently the highest. Station N3 always

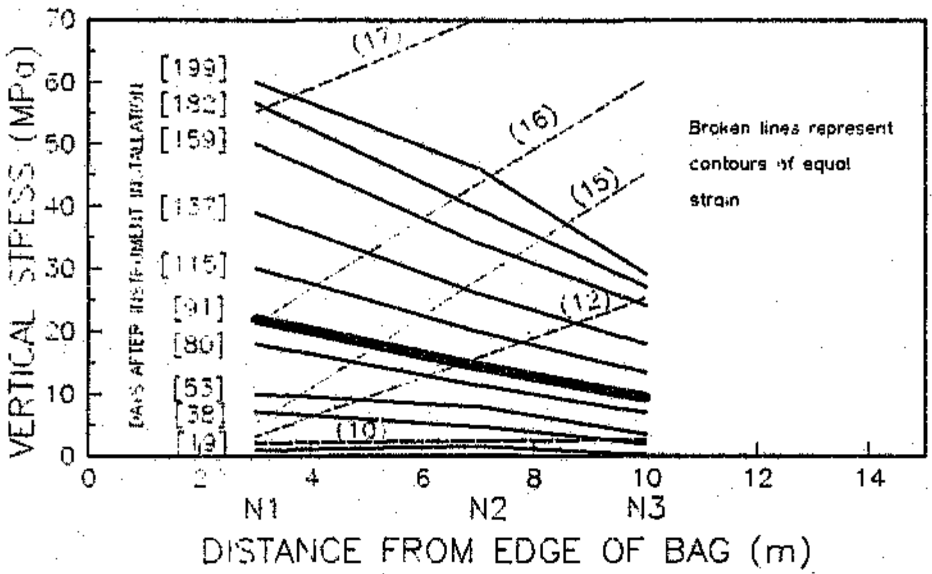

Figure 4.22 Daily stress profiles across a dip section of a backfill rib at Site N. The broken lines indicate stresses at equal strain.

experiences the lowest of the three stresses recorded at a given time. However, at equal strain, represented by broken lines, the stresses are lowest at Station N1 and greatest at Station N3.

The bold line in Figure 4.22 represents the stress profile across the bag after 91 days. At N1 the vertical stress was 22 MPa, at N2 it was 16 MPa and at N3 10 MPa. The equivalent strains recorded at the three stations were 16 %, 12 % and about 11 % respectively. As described above, an increase in closure is expected towards the backfill edges and therefore it is anticipated that the strains will be higher. As a result, the stresses will also be higher if the backfill is sufficiently confined.

Station N3, which is near the backfill centre, has the widest stoping width of the three stations and the slowest closure rate. However, it takes less strain to reach a given stress than at the other two stations as can be seen from the constant strain lines.

The stress profile in unlikely to climb towards the backfill edge and probably falls off rapidly within 2 m of the edge (because of dilation) at which it is close to zero.

The field measurements demonstrate that comminuted waste backfill, similar to other uncemented backfills, is stiffer towards the centre of the backfill rib due to increasing confinement deeper into the fill. The closures in backfilled stopes were least near the centre of a backfilled rib and increased to a maximum at the gully positions. This behaviour is controlled by the backfill's resistance to stress.

4.4.2 Classified Tailings Backfill

Data from classified tailings Site P, which was located on the same mine as Site N, are shown in Figure 4.23. Site P is one of four similar sites established in the same stope. Lines joining the stress values at three points P1, P2 and P3 on a selected number of days are shown. The stoping widths for Stations P1, P2 and P3 are 790 mm, 800 mm and 850 mm respectively. Also shown on the graph and indicated by broken lines are contours of equal strain recorded at the measuring stations.

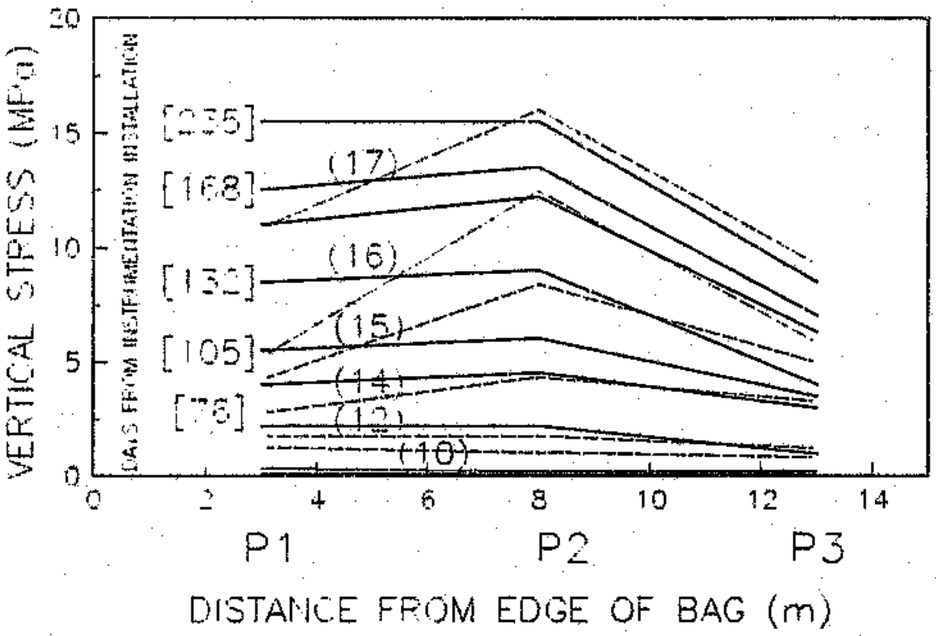

Figure 4.23 Daily stress profiles across a dip section of a backfill rib at Site P. The broken lines indicate stresses at equal strain.

The two stations closest to the edge of the bag show similar stresses while the stresses at Station P3 at the centre of the backfill are consistently lower. The broken lines representing the contours of equal strain, which are also shown on Figure 4.23, have an apex at Station 2 and slope downwards to Stations 1 and 3.

At Station P1 the stresses that are generated occur at higher strains than for similar stresses developed at Station P2. This is in spite of the fact that the stoping width is slightly less at P1 than at P2, suggesting that the backfill may be exhibiting softer behaviour at P1 than at P2 because of dilation of the backfill. The fact that Station P3's stress values are consistently lower than those of P1 and P2, and at similar strains to P2, suggests that at Station P3 the backfill was less stiff because of the relatively high stoping width and limited closure at this point.

4.4.3 Dewatered Tailings Backfill

The in situ behaviour of dewatered tailings backfill was determined at a gold mine in the Far West Witwatersrand region. The complete backfill rib behaviour of dewatered tailings backfill was determined at two different sites on the mine but only one set of data will be discussed in this section.

Figure 4.24 shows the vertical backfill reaction stresses with respect to distance from the edge of the backfill bag, at four measuring stations (C1, C2, G and C3). The stoping widths at the location of the stations were 980 mm, 1320 mm, 1255 mm and 1190 mm respectively. Each stress profile joins the daily stress measurements taken at the four stations. Also displayed in Figure 4.24 are lines which join stress values that occur at equal strain, determined from closure measurements at each of the four stations.

The thick vertical stress profile shown in Figure 4.24 is used to demonstrate the relationship between the daily vertical stress and equal strain profiles. From this profile the equivalent stress and strain values are as follows: Station C1 registered 12,5 MPa at 19,5 % strain, Station C2

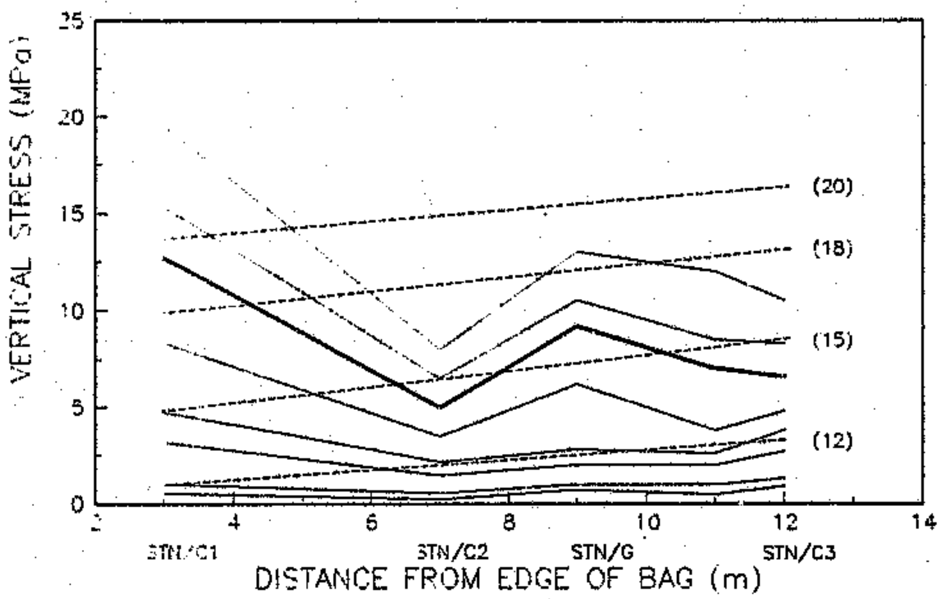

Figure 4.24 Daily stress profiles measured across a dip section of a backfill bag at Site C. The broken lines indicate stresses at equal strain

registered 5 MPa at 14 % strain, Station G registered 9 MPa at 16 % strain and Station C3 recorded 6,5 MPa at 14,5% strain. The calculated equivalent Young's Modulus for the four stations were 67 MPa, 33 MPa, 45 MPa and 45 MPa respectively. These values vary by less than a factor of two, which is not significant.

The magnitude of vertical stress in the confined compression region of the backfill rib is governed by the stoping width and closure at that point. If the stoping width is small, and/or greater closure is measured at a station, then consequently higher strains induce higher stresses at that station. As also shown by Gürtunca et al (1989), the maximum closure occurs in the gullies and the closure reduces towards the centre of the backfill rib.

The stoping width at Station C1 was smaller than at the other stations and, since this position was closer to the edge of the rib, more closure occurred here. This resulted in high vertical stresses at this station, while relatively smaller and more variable vertical stress values were measured at the other stations. However, it should be noted that the first two metres from the edge of the backfill usually experience dilation or bulging resulting in the high stress values falling off rapidly towards the edge of the backfill.

4.5 K-ratios

The term K-ratio used in this dissertation refers to the ratio of the horizontal stress measured in the backfill to the vertical stress measured at the same point. The horizontal stresses were measured in the dip or strike direction. If a material is confined, the build up in horizontal stresses should be faster as a result of vertical loading than if the material were unconfined. Such a parameter may be a useful tool to assess the backfill's three dimensional behaviour.

In general the K-ratios are erratic at low strains. This corresponds to low stress levels. Large variations in ratios at low stresses should be ignored because of the errors in measuring and instrument inaccuracy at these levels.

4.5.1 Comminuted Waste Backfill

The K-ratios for typical comminuted stations are plotted against strain in Figure 4.25. The positions of the stations vary from the centre of a backfill bag to within a metre of the edge of the backfill edge. Generally, the ratios fall in a broad band between 0,3 and 0,6 after approximately 7,5 % strain. The values of stress prior to 5 % strain are less than 1 MPa for both vertical and strike stress. Above 7,5 % strain, the vertical stresses were between 1 and 5 MPa. The K-ratios are grouped together and become constant beyond this strain, indicating the existence of K_0 loading conditions which implies fully confined conditions or zero strain laterally. There appears to be no pattern of strike/vertical stress ratios displaying a different behaviour to dip/vertical stress ratios. Nor does there appear to be a marked difference between K-ratios at stations deeper into the fill compared with those nearer the edge. The station 1 m from the backfill edge (Station Q) does display a characteristically lower K-ratio for the strike to vertical stress.

This inconsistent K-ratio reading near the edge of the bag, where the dip/vertical value was higher than the strike/vertical value, [illegible]e explained by the presence of a pack immediately down dip of that bag. Down dip, on both sides of the instrumented bag, there were no packs and therefore these two bags would dilate down dip more easily than the instrumented bag. Hence, the instrumented bag would be able to move sideways more easily than down dip and therefore a higher dip/vertical stress ratio is possible.

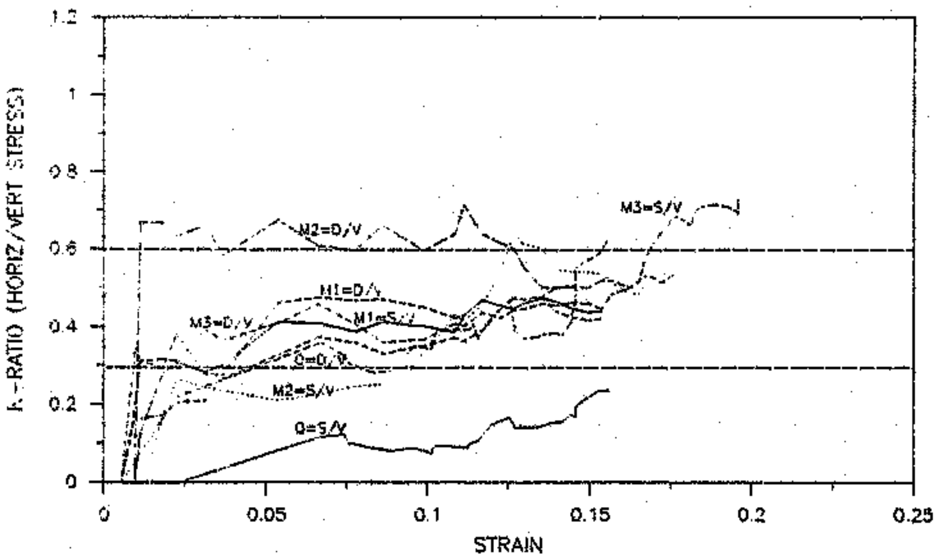

Figure 4.25 K-ratios plotted against strain for comminuted waste backfill

4.5.2 Classified Tailings Backfill

The K-ratios from a classified tailings backfill site fall in a band from 0,3 to 0,6 beyond approximately 20 % strain (Figure 4.26), at vertical stresses between 8 and 11 MPa. The K-ratios within this band are constant, which is indicative of K_0 conditions, as discussed above. Prior to 20 % strain, the K-ratios are erratic. There appears to be no relationship between a K-ratio and the station position relative to the edge of the bag. The strike or dip stress direction K-ratios do not show any distinctive differences in values.

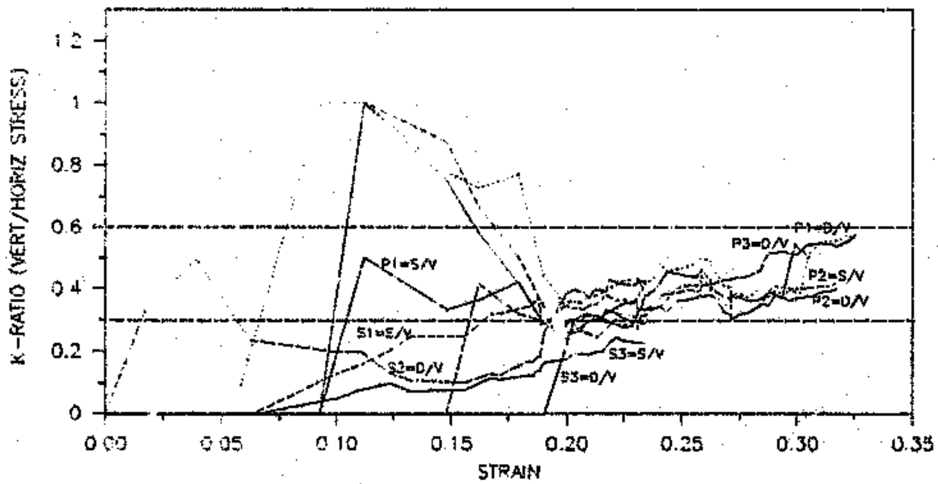

Figure 4.26 K-ratios plotted against strain for classified tailings backfill

4.5.3 Dewatered Tailings Backfill

The variation in the K-ratio with respect to time, at three different sites on one mine installed in dewatered tailings backfill, is shown in Figure 4.27. Site C, discussed above under the stress-strain profiles, is one of the three sites. The K-ratios at stations B1 and B3 begin at values as high as two and then decrease to around 0,5 in the first 90 days of measuring. The vertical and horizontal stresses were less than 1 MPa during this period. The readings from the low range stress meters may not be particularly accurate which may account for the high initial K-ratios at these stations. The K-ratios at other stations increase from zero and level off to relatively constant values of between 0,4 to 0,6. The constant value of the stress ratio is typical of fully confined conditions and as such can be defined as the K_0 ratio.

The variation in the K-ratio shown in Figure 4.27 indicates that triaxial loading conditions occurred for about the first 200 days of measuring, resulting in changes in the K-ratio with time. Later the K-ratios become almost uniform indicating that K_0 loading conditions apply. The stress measurements show that constant K_0 ratios occur in the backfill when the vertical stresses reach 6-7 MPa at 14 % strain.

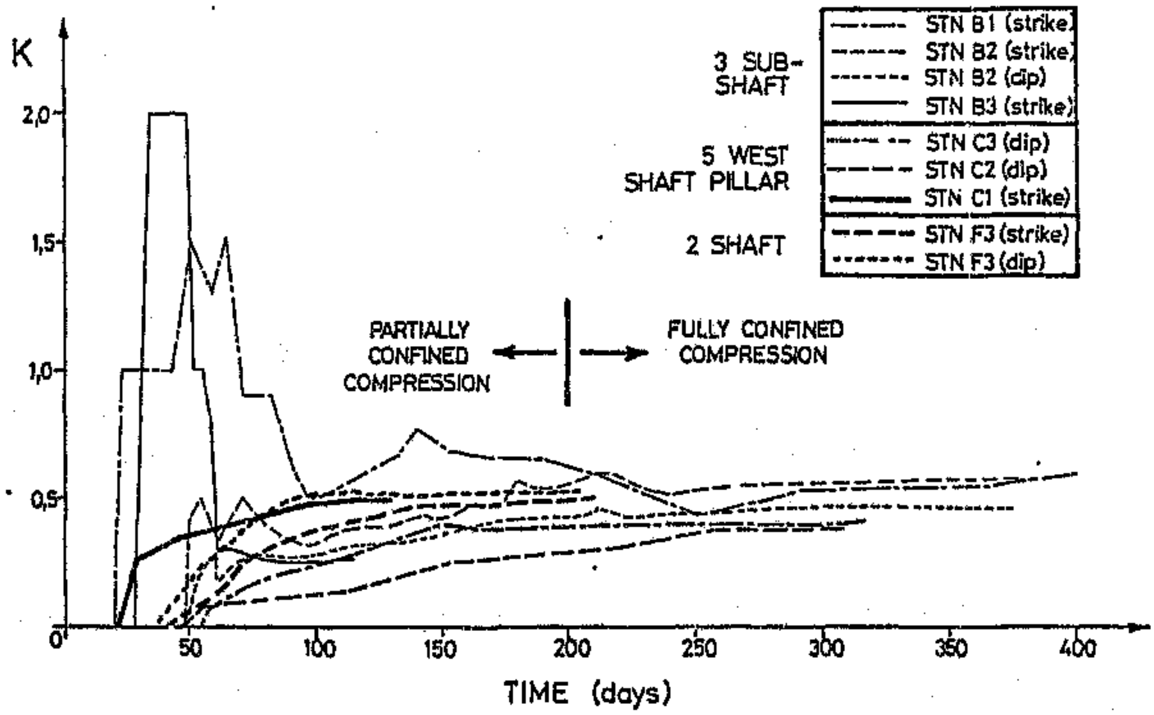

Figure 4.27 K-ratios plotted against time for dewatered backfill tailings

5 LABORATORY WORK

This chapter examines the distribution of stresses at constant strains across a backfill rib constructed in the laboratory. A second laboratory test to determine the effect of the inclination of stress meters to th applied stress field on the readings obtained by the stress gauge is also described. The results of a laboratory test which was set up to establish if the stress cells themselves modified the stress regime in the backfill is discussed.

5.1 Motivation for performing laboratory work

Laboratory test work to determine the principal stress levels in backfill was carried out because of a concern that at least two of the stresses measured at the underground sites were probably not the principal stresses, and may have been sufficiently different from the principal stresses to exclude their use in any stress analysis in their raw form. This is because the stress cells for measuring the dip stress in the plane of the reef and those for measuring stresses at right angles to the reef were installed at right angles and parallel to the reef plane respectively (Figure 5.1).

In order to assess the sensitivity of the stress cells at the underground test sites to different inclinations relative to a given stress field, it would have been necessary to be certain of their original inclination and to excavate them, following some deformation, to record their final inclination. Installation of instruments and the problems of ensuring their exact positions during filling and

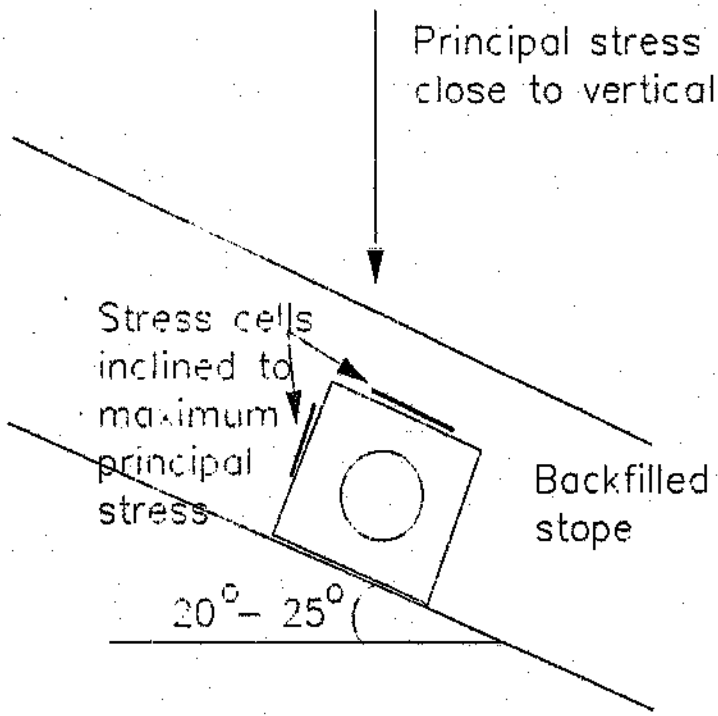

Figure 5.1 Schematic diagram showing the orientations of stress cells installed in the backfill relative to the expected principal stress directions

throughout the monitoring programme is extremely difficult underground. Also, extracting instruments from the backfill once the fill has experienced any vertical deformation is dangerous and sometimes impossible. Therefore, experiments were conducted in the laboratory with stress cells inclined at different angles to the principal stresses to quantify the relationship between the angle of inclination anc the stress measured by the stress cell.

It was felt that a set of simple laboratory experiments in which the stress cells were inclined at different angles from the horizontal would give the best indication of the sensitivity of stress cells to changes in the angle between them and the principal stresses. The necessary adjustments to field measurements to arrive at principal stresses could then be made, if in fact the stresses measured in the field were found or thought to be significantly different from the principal stresses.

A classified tailings backfill was used in two laboratory tests. The sample had an initial porosity of 46 per cent and a moisture content of 6 per cent when tested.

Two backfill ribs of dimensions 1 m x 1 m were constructed and miniature stress cells were placed in each rib. The one rib was 132 mm thick and the other 120 mm thick. The ribs were confined in one horizontal direction and open in the other, similar to backfill underground.

The samples were loaded using a 25 MN hydraulic press with the stress build up in the backfill being read at 1 MN intervals, as registered by the pressure of the hydraulic fluid of the press. The tests effectively represent parallel-sided stopes closing at all points at the same rate. Therefore, the stress readings taken at a particular applied pressure are also at a particular strain value.

Other reasons for conducting laboratory tests were to assess the role played by the actual stress cell in modifying the measured stress. It was felt that the presence of an inclusion in the backfill might redistribute stresses around such an object. The result would be that the measured stress would be different to that which was being applied to the backfill. In order to understand the relationship of vertical to horizontal stresses and the stresses which act at a number of points across a backfill rib, further laboratory tests were conducted.

The stress cells used in all these experiments were specifically designed for the tests and were approximately 50 mm in diameter. The stress cells were manufactured from metal and filled with hydraulic fluid. Each stress cell was connected to a pressure transducer by a brass pipe sheathed in a protective sleeve to guard against possible damage from high stresses in the backfill. The changes in pressure measured in the hydraulic fluid were converted to an electrical signal by a pressure transducer and were amplified and read using a multimeter. They were all calibrated before the tests began and a random sample of these instruments were again calibrated after the tests. No appreciable difference was noted on those tested.

The scale effect of the laboratory experiments is probably significant. This is due to the fact that, while the laboratory backfill rib and stress cells are very small in comparison to their in situ dimensions, the grain size of the backfill remains the same size. However, the scale effect has not been determined and therefore the results are used comparatively rather than for calibration purposes.

5.2 Inclined stress cells

A laboratory test was set up in which stress cells were inclined at varying angles from the horizontal in the backfill. The cells were positioned along the plane of symmetry through the centre of the rib to ensure that the conditions at each cell were similar, except for their inclination to the horizontal. The stress cells were inclined at 0, 20, 30 and 40° from the horizontal (Figures 5.2 and 5.3). The 25 MN press at COMRO was used to load a sample of classified backfill, 1 m x 1m and 130 mm high. The backfill was placed in a steel channel, confined on two sides and open on the other two sides (Figure 5.4). While preparing the sample, wooden boards were placed at the open sides of the frame to form vertical edge restraints for the backfill. Approximately 60 mm of backfill was placed in the frame before the stress cells were positioned and then the remainder of the backfill was placed on top of the cells, taking precautions to ensure that their positions and attitudes were maintained. A metal plate was placed on top of the backfill and the wooden boards were removed from the open ends of the channel. The backfill was loaded vertically and the maximum principal stress was therefore assumed to be vertical. Stress readings were obtained from the stress cells at specific values of vertical deformation.

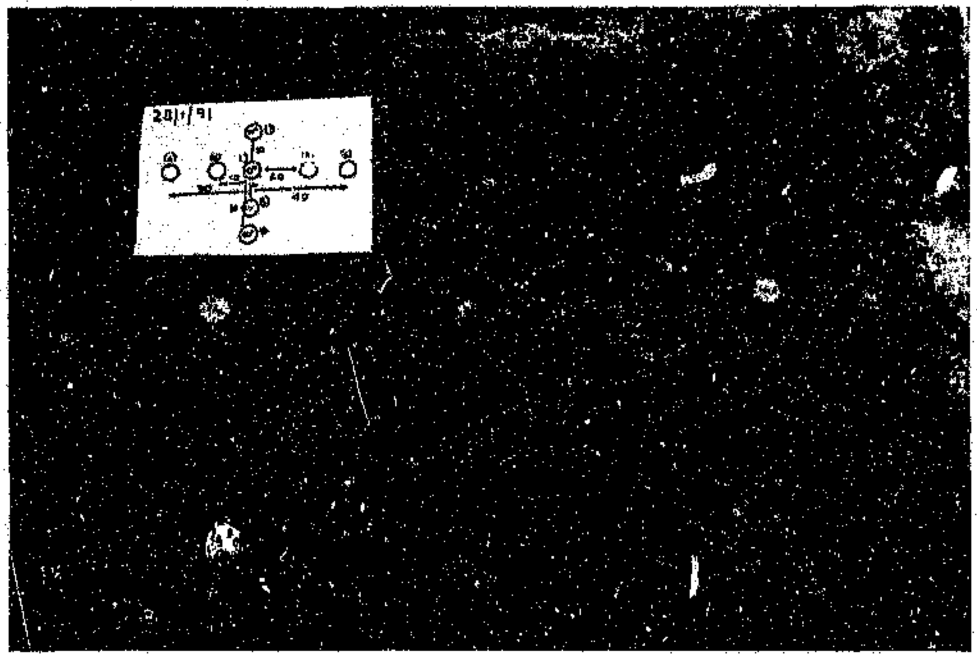

Figure 5.2 Photograph showing the layout of miniature hydraulic stress cells after compression of the backfill and later excavation around the cells.

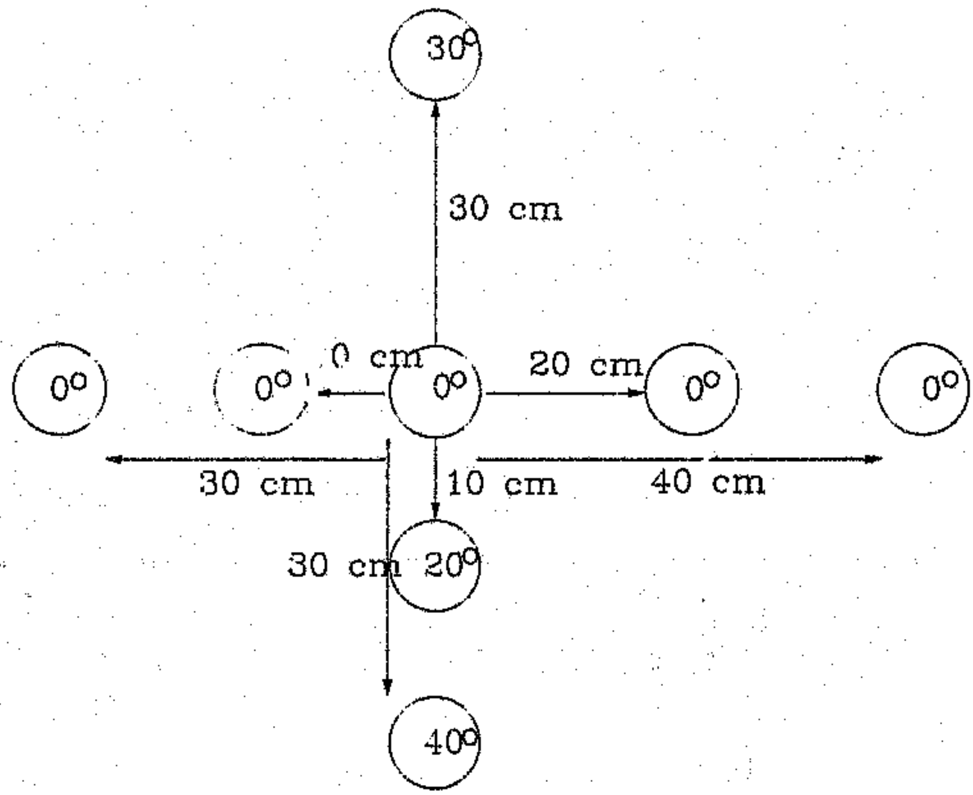

Figure 5.3 Drawing showing the layout of miniature hydraulic stress cells in the laboratory backfill test. The inclination of the cells to the horizontal is indicated at each cell.

Figure 5.4 Photograph of the open ended container after the backfill has been compressed. The tubes connecting the stress cells to the transducers are visible in the photograph.

5.3 Modification of the stress field by the stress cell

A laboratory test was conducted to ascertain whether the stress cells were modifying the stress field which they were measuring. In this experiment backfill material was placed in an oedometer. Miniature stress cells were placed horizontally in the backfill as it was poured into the test cell. Two of these stress cells were placed at the mid-height of the cell, one at the centre and the other at the edge. A third stress cell was placed in the top quarter of the backfill, at the edge of the oedometer (Figure 5.5). A load was applied to a platen which fitted into the oedometer and the stresses acting on the backfill sample were calculated at various predetermined loads. Simultaneously to the predetermined loads being applied externally to the backfill in the oedometer, stresses were read from the various stress cells positioned inside the backfill.

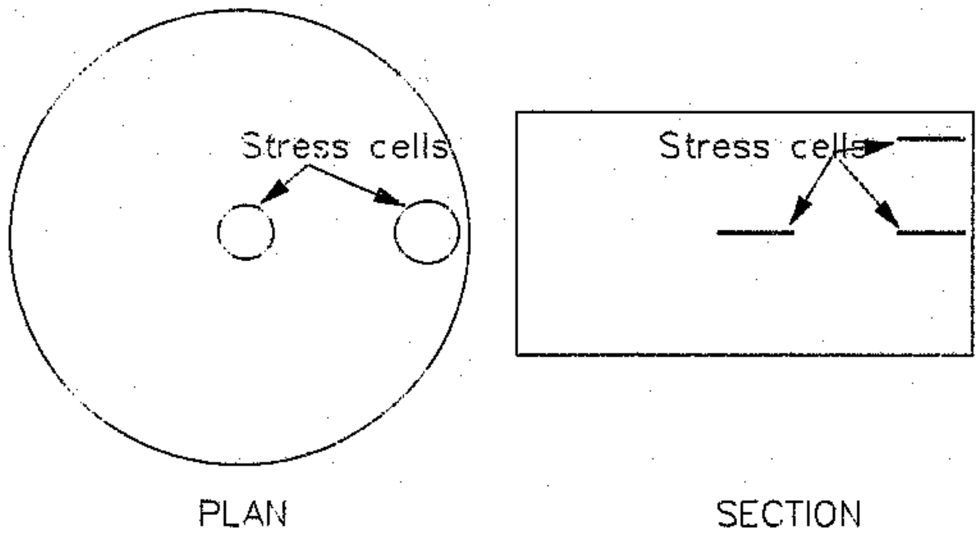

Figure 5.5 A schematic of the experiment conducted to assess the influence of the stress cells on the stress field

5.4 K-Ratios

Three sets of three orthogonal stress cells were placed inside a backfill rib in the laboratory in order to determine the relationship between the build-up in horizontal stress and vertical stress as the backfill sample was loaded. One set of stress cells was placed at the centre of the rib, one was positioned at the edge of the backfill and a third was placed mid-way between these two positions (Figure 5.6). A 60 mm layer of classified backfill was first placed in the same 1 m x 1 m steel container used in the experiment with the inclined stress cells. The stress cell sets were then positioned in the backfill and their positions maintained as another 70 mm layer of backfill was placed in the container. The backfill was confined on the two open ends of the channel using wooden boards. A steel plate was placed on top of the backfill before the wooden restraints at the two edges were removed. The sample was then placed in the 50 MN press and loaded. Stresses were read from the stress cells at predetermined values of vertical deformation of the backfill.

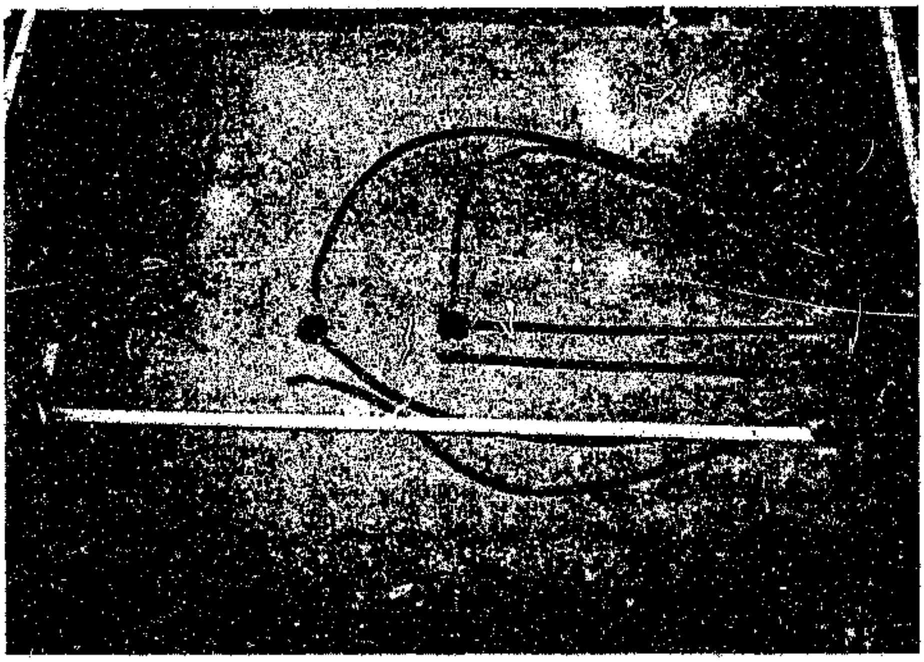

Figure 5.6 Photograph of the layout of the hydraulic stress cells for measuring stress in three mutually perpendicular directions in the backfill sample.

5.5 Backfill rib behaviour

In order to obtain a profile of the vertical stresses across the backfill sample, horizontal stress cells were placed in the backfill rib in the laboratory. The stress cells were positioned to measure confined and unconfined backfill performance. The experiment was conducted in the same sample of backfill as the test with inclined stress cells (Figure 5.2). The dimensions of the backfill rib were 1 m x 1 m and 120 mm high. The stress cells were placed at mid-height of the backfill. Stresses were read from the stress cells at set values of vertical deformation of the backfill.

5.6 Results of laboratory tests

5.6.1 Inclined stress cells

Unfortunately, the stress cell that was inclined at 20 degrees ceased to work after only 13 % strain. Prior to failure, the stresses in this cell varied from the horizontal cell by only approximately 5 %. It is considered that if it had not failed this trend would have been maintained or possibly the difference between the two cells would have become even smaller. The reason for this is that, on excavating the cells after the test, all the inclined cells had rotated towards the plane perpendicular to the applied maximum principal stress. The 20 degrees cell was almost horizontal while the 30 and 40 degrees cells had each rotated by 13 degrees. There was no evidence of voiding above or below the stress cells.

It is highly likely that any stress cells installed underground at any inclination would tend to rotate towards the principal planes with closure of the stope. However, it should be emphasised that at the field sites the stress cells were all attached securely to cubic wire cages which were in turn secured to the footwall of the stope. The edges of the cages were thus parallel to the co-ordinate system of the reef plane so that, in general, the cells were parallel or perpendicular to the reef plane.

Prior to the compression of the sample, the backfill was loose and easily moulded. After the test, which reduced the height of the backfill by approximately 50 %, the backfill was extremely hard and only removable by means of a trowel and water. This had the advantage that the final positions of the stress cells were simple to determine and their final angles to the horizontal plane were possible to measure.

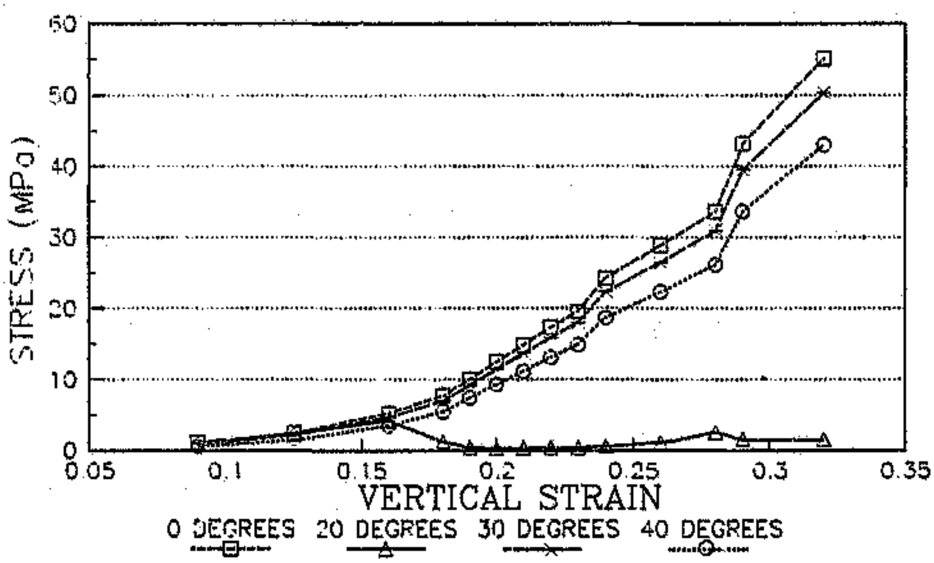

Figure 5.7 Stress-strain relationship for stress cells inclined at different angles to the maximum principal stress (laboratory test)

The differences in the stresses measured were most pronounced a. lower strains. By about 18 % strain for both cells, the percentage change in stress from the horizontal cell had dropped to a constant level, 25 % and 8 % for the 40 degrees and 30 degrees cells respectively. The maximum stresses measured before this strain are approximately 7

MPa. It is uncertain why the more steeply inclined stress cell recorded smaller percentage changes than the less steeply inclined one. Although every attempt was made to ensure uniformity of the backfill, it is possible that there may have been some inhomogeneity in the backfill.

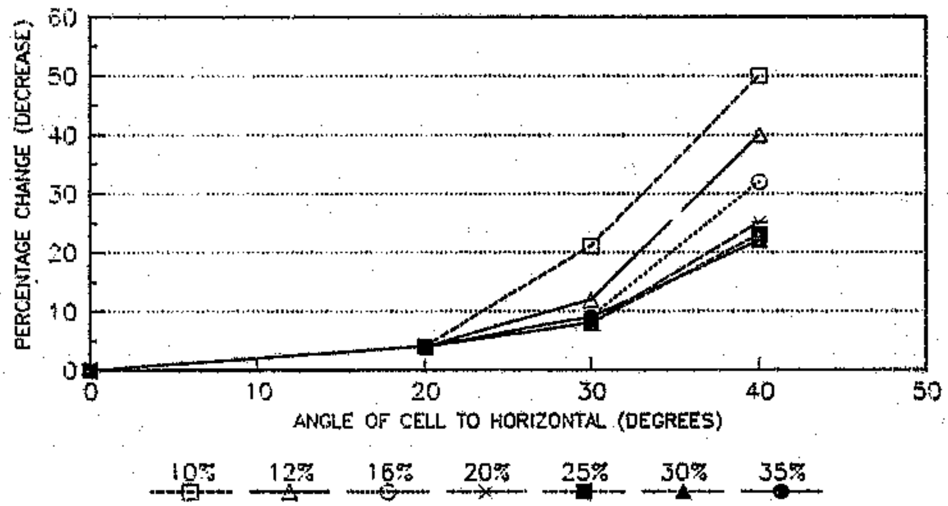

Figure 5.8 Percentage decrease in the magnitude of stress measured at stress cells inclined at increasing angles to the horizontal stress cell at chosen strains

The laboratory tests show that, if the stress cells are inclined at less than about 25 degrees from the principal plane, it is likely that the decrease in stress measured may only be approximately 5 % at low strains and even less at strains higher than approximately 18 %. Figures 5.7, 5.8 and 5.9 show the information relevant to the above discussion.

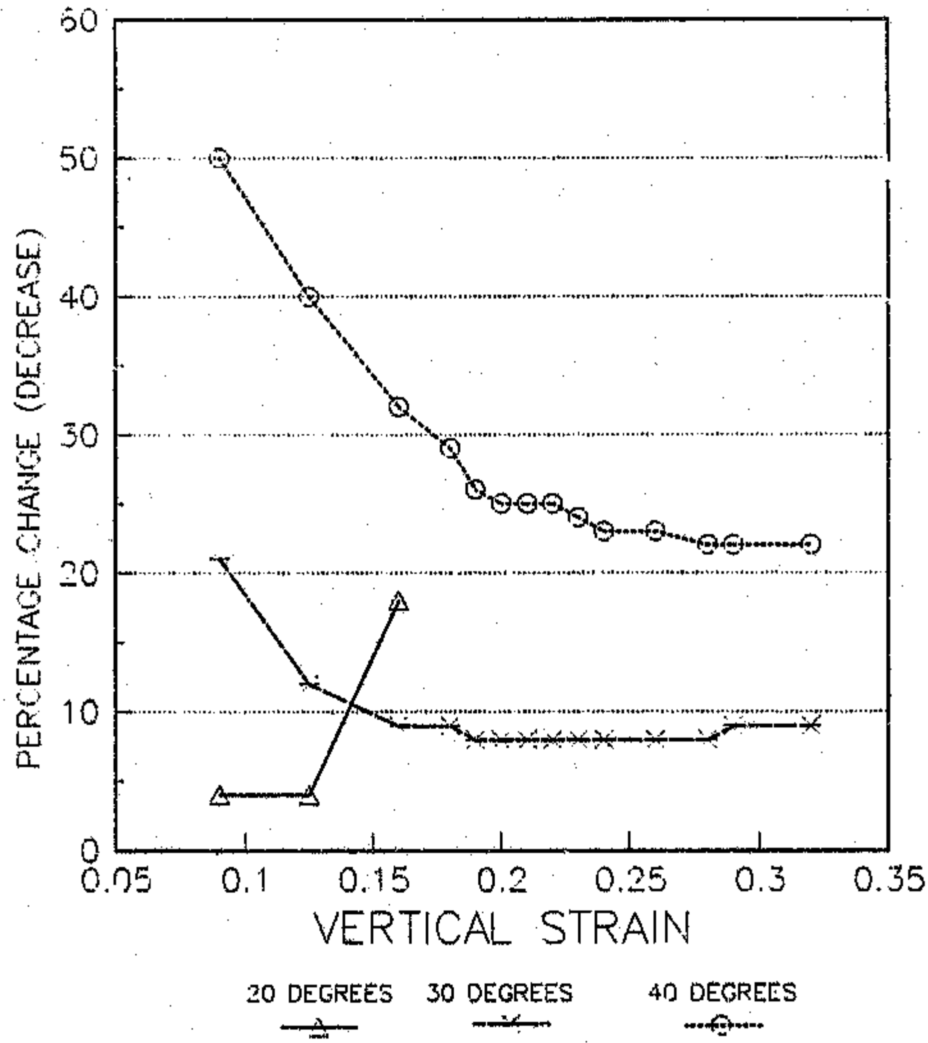

Figure 5.9 Diminishing percentage decrease in the magnitude of stress, measured at three inclined stress cells, compared with a horizontally positioned cell, with increasing strain

5.6.2 Modification of the stress field by the stress cell

The results of the experiment which was conducted to assess the influence of the stress cells on the measured stress are presented graphically in Figure 5.10. It is clear from the figure that there is good agreement between the applied stresses and those measured inside the backfill using the stress cells. It is therefore concluded that the stress in the backfill is not significantly modified by the presence of the stress cel_s and that the stresses read by stress cells are in fact close to those acting throughout the backfill.

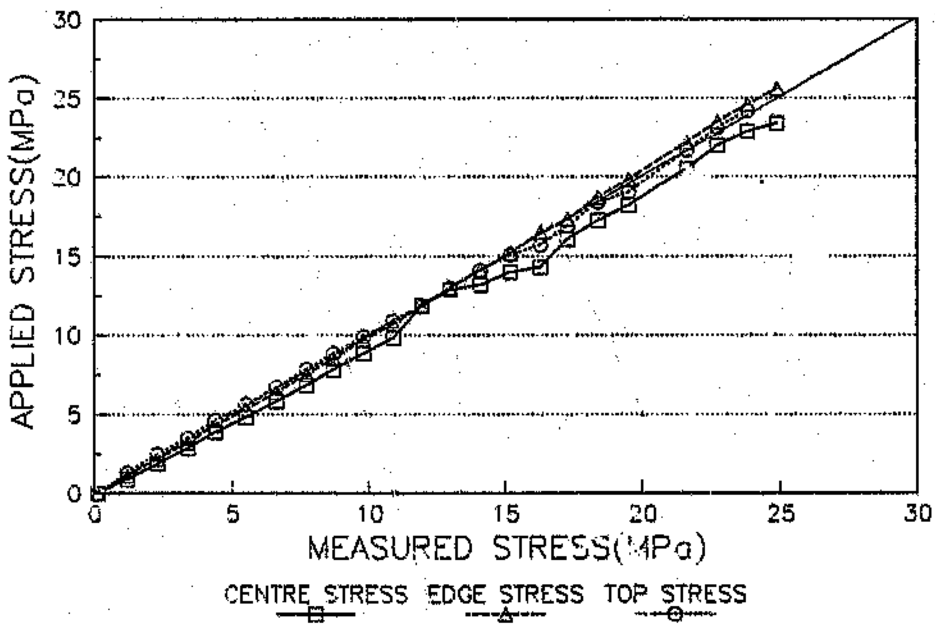

Figure 5.10 Relationship between the applied and measured stress at three stress cells in backfill in an oedometer.

5.6.3 K-Ratios

The experiment in which backfill material was placed in a channel with two open ends was used to determine the K-ratios in backfill in the laboratory. The stress cells closest to the edge of the backfill were too close to the edge and therefore did not build up any horizontal stresses; it therefore was not possible to calculate K-ratios or horizontal to vertical stress ratios for this position. K-ratios were calculated from the other two sites and these are shown in Figure 5.11.

In the first test, stresses were measured in three orthogonal directions at three positions in the backfill along the axis of unconfinement. Station 1 was in the centre of the rib, Station 2 was positioned equidistant from the centre and edge of the bag and Station 3 was installed 5 cm from the backfill edge.

The pressure cells from the end station were tested and found to be in good working order after the experiment. The other two stations which did register stresses have been used to calculate K-ratios.

During the compression test, the stress readings at the centre station strike pressure cell suddenly lost pressure, resulting in a large drop in the strike to vertical stress K-ratio. At first it was thought that the cell had burst but, later, stresses built up and reached 27 MPa at which stage the test was stopped. On excavating the stress cells from the backfill at the completion of the test, it was found that the particular cell which had lost pressure had rotated from its vertical orientation. Therefore, the stress adjustment must have been associated with stress alteration in the backfill which possibly caused the stress cell to rotate, rather than failure of the cell itself. All the other ve: ically-oriented stress cells showed only slight if any rotation.

The K-rat : for the laboratory test fall within a band from 0,3 to 0,6 (Figure 5.11). These values are reached at lower strains (10-15 %) at the centre station than at the station further from the centre (25 %). The strike (confined direction) to vertical stress ratios both have high initial values of ~out one and maintain higher values than the dip (nfined direction) to vertical stress ratios. Both of the dip to vertical stress ratios are low initially. This is expected as the backfill is confined in the strike direction and unconfined in the dip direction. The extreme values of K-ratio recorded initially are possibly partly a result of the inaccuracy of instruments at low stresses and partly as a result of the rapid loading rate applied in the laboratory. The high strain that is necessary to reach constant K-ratios is similar to those experienced in classified tailings monitored underground.

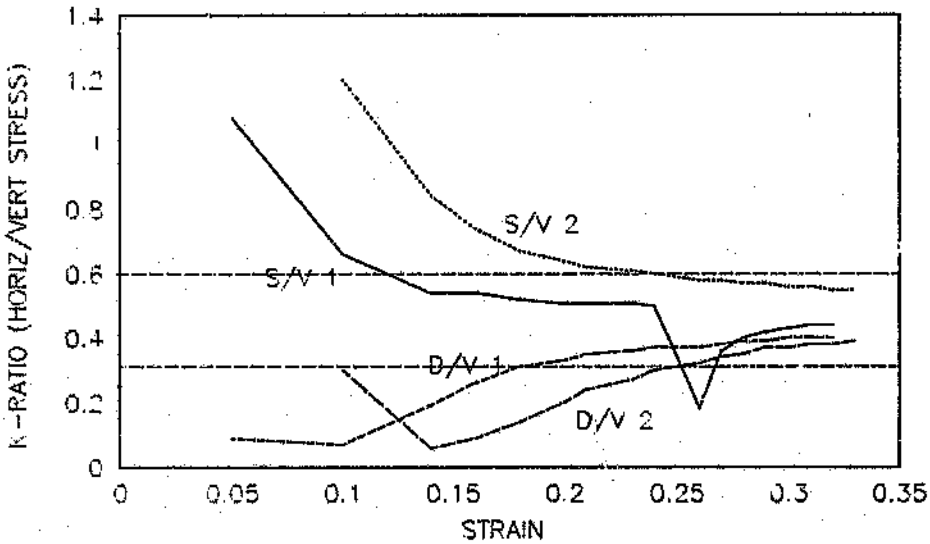

Figure 5.11 The K-ratios calculated from the laboratory test plotted against strain.

5.6.4 Three dimensional behaviour

In the second laboratory test five stress cells were oriented horizontally in the backfill, with the first cell at the centre of the rib. The remaining four cells were positioned at 10 cm intervals towards the backfill edge.

The results of the experiment are shown in Figure 5.12, where lines of constant strain link the stresses recorded at each of the five stations in the backfill. The maximum stress at any strain is always recorded at the centre of the rib and the stresses become progressively lower towards the edge of the backfill. The station furthest from the centre of the rib was 10 cm from the edge of the backfill. If the strain contours are extrapolated beyond the fifth station, it is clear that they will intersect the zero stress line close to the fifth station. The previous test showed that no stress was recorded at 5 cm from the backfill edge, so zero stress may have been reached at some point between 5 and 10 cm from the edge in this test sample.

The distance of the fifth station from the backfill's edge is approximately 1/10 of the rib width and slightly greater than the backfill thickness. If no scaling effects are taken into account, it could be argued that a similar stress situation will occur underground in backfill. Wide backfill ribs in a 1 m wide stope may not experience any stress build-up in the first metre from the edge, if totally unconfined. Usually there is some form of confinement underground such as geotextile material, timber barricades or packs, but this effect is probably negligible.

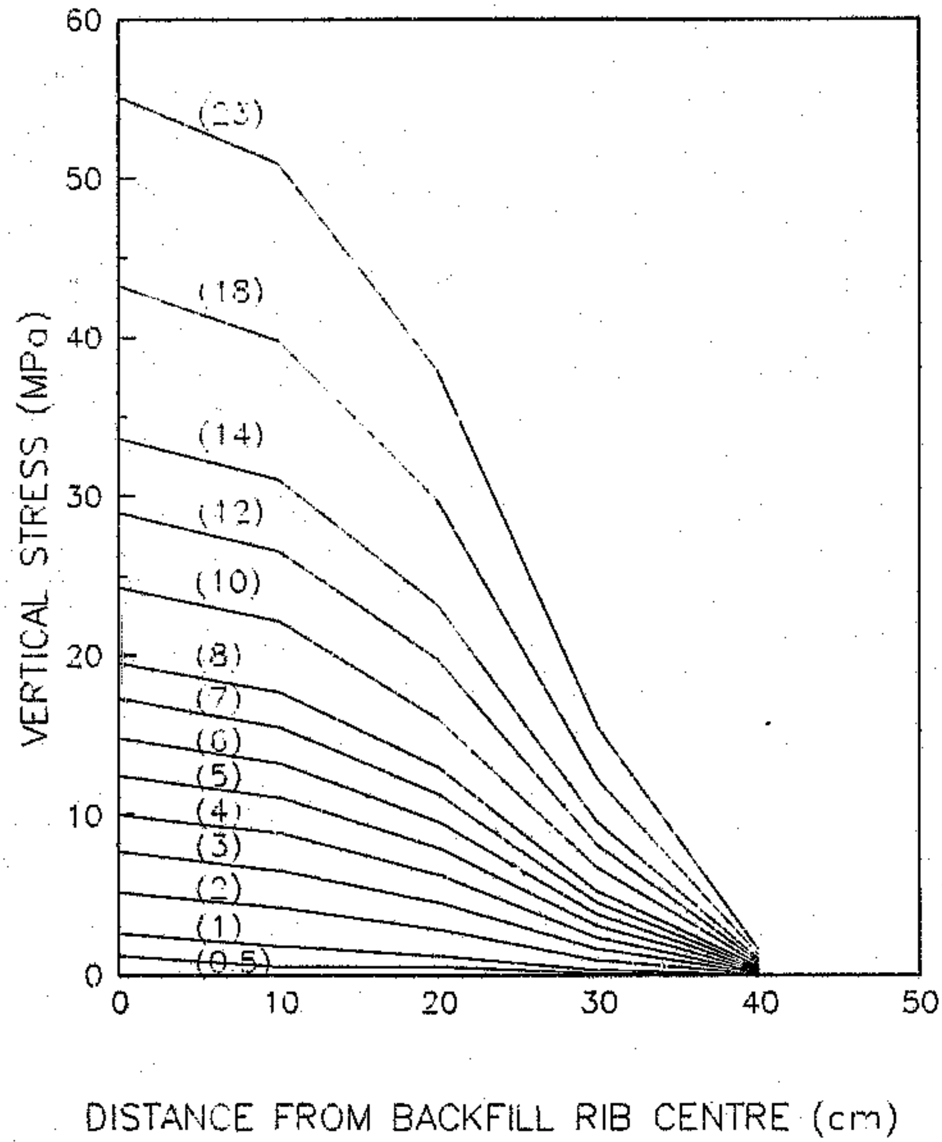

Figure 5.12 Plot of the stresses recorded at constant strains during the laboratory test. Stresses are highest at the centre of the backfill rib at any strain

6 MODELLING

6.1 Motivation and rationale for modelling

In order to simplify the interpretation and comparison of the three dimensional state of stress in backfill ribs, principal stresses should be used. If principal stresses are measured then there is no need to measure shear stresses in the backfill. If stresses close to the principal stresses are measured then the shear stresses are very small and can be ignored. Therefore, it is important to establish how different the recorded field stresses are in magnitude to the principal stresses that are derived from numerical models that simulate similar underground conditions. These computer models are capable of predicting the trajectories of the principal stresses acting in the rockmass around a backfilled stope. The determination of stress trajectories surrounding a stope by field measurements was not undertaken in this research project. While it is possible to obtain such information using strain measuring devices such as CSIR "doorstoppers", the procedure is difficult, especially in rock close to stopes, and when carrying out the measurements from within stopes. In addition, the results are not always reliable.

In an unfilled, horizontal stope it is expected that close to the stope hangingwall, the maximum principal stress would be close to horizontal and the minimum stress would be close to vertical and could even be tensile. However, in backfilled stopes the trajectories of the principal stresses are far more difficult to predict, particularly if the stope is only partially filled. The use of MINSIM-D, a linear elastic model, is ideal for establishing the approximate trajectories of the principal stresses in the rockmass above and below a backfilled stope. It is thus possible to calculate the angle between these trajectories and lines perpendicular to the reef plane, which are the trajectories of the stress acting on the stress cells.

Most stopes in which stress measurements were recorded dip at angles between 20 and 25°. The stress cells in the stope were always installed in an orthogonal array, with one stress cell parallel to the plane of the reef. If the trajectory of maximum principal stress was actually vertical, it may have been inclined at up to 25° from the perpendicular to these stress cells.

Site specific stope models for the Western Deep Levels monitoring site were set up and run, using MINSIM-D, to establish the trajectories of the maximum principal stress. The magnitude, altitude and azimuth of these trajectories were compared to the stresses acting co-axially with the reef coordinate system to ascertain if the differences between them were significant.

The parameters used in the MINSIM-D models are listed in Appendix B.

Two models were run of the same area, one with backfill or soft seam material, and the other without support in the mined out area. The same two areas in each model were selected, with 12 benchmarks in each, for establishing the values and trajectories of the principal stresses in the immediate hangingwall of the stope.

The backfill material used in the modelling was defined as having a hyperbolic stress-strain relationship. Only two values are given to describe the curve; 'b' which is the ultimate strain of the material, and 'a' which is the stress developed in the backfill at half the ultimate strain. Figure 6.1 shows how the 'a' and 'b' values are determined from a backfill stress-strain curve.

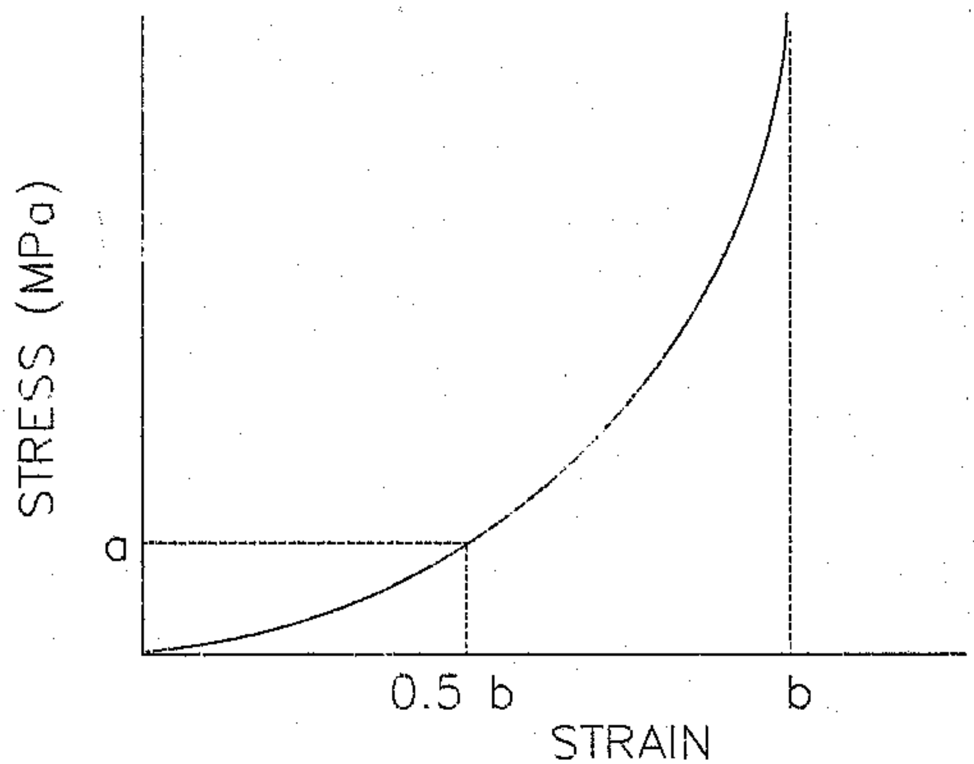

FIGURE 6.1 Schematic of a stress-strain curve for backfill material indicating how values of 'a' and 'b' are derived from the curve.

FLAC modelling was used to confirm the MINSIM-D modelling. Simple 2-dimensional models, 50 m x 50 m were set up with boundary and internal stress conditions to simulate rock at approximately 2000 m depth. A stope was positioned in the finite difference grid in different simulations with the stope dipping at 0 to 45 degrees respectively. Six different models were run with varying quality elastic backfill and even without backfill in the stope. The backfill placed in the stope had a width to height ratio of 1 to 15. The models were all time stepped to equilibrium and the trajectories of the principal stresses were then examined.

The parameters used in this FLAC modelling are listed in Appendix B.

FLAC models were also used to examine the stress profile which would result across a horizontal backfill sample, simulating the backfill samples tested in the laboratory. The backfill was modelled as a soft elastic material and as a material with Mohr-Coulomb behaviour between stiffer platens in separate FLAC models. Uncemented backfill materials behave inelastically, but the load distribution across a rib with soft elastic material was expected to be similar to that for a Mohr-Coulomb material. This is because of the unconfined conditions at the edge of the backfill which allows the material to dilate horizontally at this position. Thus at the edge of the backfill there is reduced resistance to loading compared with the centre or confined portion of the backfill rib. If the model is not strained excessively then the elastic backfill behaviour will be similar to the behaviour of a Mohr-Coulomb backfill model. The models simulated backfill ribs with a width to height ratio of 10:1. The loading platens were 4,5 times the width of the backfill and the backfill was unconfined in the horizontal direction. A pressure of 1 MPa was applied to the top of the model to simulate the pressure which is built up by the resistance of the backfill to loading. FLAC models are two dimensional and therefore plane strain conditions existed. The input file for the two FLAC runs are in Appendix B.

6.2 Results of modelling

As expected, the MINSIM-D model in which no backfill had been placed had not experienced total elastic closure of the stope, and thus the stresses in the immediate hangingwall of the stope were tensile. The model which incorporated backfill or soft seam material showed that maximum compressive stresses of up to 14 MPa existed in the immediate hangingwall of the stope under the conditions selected for the model. The values of the stresses were not as important as the azimuths and altitudes of the principal stresses. At one site selected, the average azimuth of the principal stresses at 12 selected points was 289° and the altitude was 84.4°. At the other site, the average azimuth of the 12 principal stresses was 273° and the altitude was 70°.

The results show that the maximum principal stress acts between the vertical position and a line perpendicular to the stope plane. The angle between the vertical and the perpendicular is a maximum of 25°. Even if the principal stress is vertical, the reading obtained from the reef parallel cell falls within acceptable limits as discussed under Section 5.1. If the angle between the principal stress trajectory and the normal to the stress cell is 25°, the stress measured by the cell would be 5 % lower than the principal stress. This would occur at low stresses; at higher stresses the difference would be less according to the tests conducted in the laboratory. The other two principal stress trajectories would also be inclined at a maximum angle of 25° to the normals to the stress cells for measuring the dip and strike stresses.

The results of FLAC modelling confirm the MINSIM-D modelling, although the FLAC model is a two-dimensional simulation. The models with an unfilled stope show characteristic maximum principal stress trajectories flowing around the excavation, irrespective of the dip of the mined slot. The models incorporating backfill material placed in the mined-out slot show that the principal stress trajectories remain extremely close to vertical, irrespective of the stiffness of the backfill or the inclination of the stope.

Therefore, it is reasonable to regard the principal stresses as acting vertically and horizontally respectively. The angles between the principal stress trajectories and the normals to the stress cells is dictated by the dip of the stope in which the instruments are placed. Up to 25° dip, the measured stress will not be significantly lower than the principal stress acting on the cell. All the backfilled sites which were instrumented, and from which data were collected for this dissertation, dip at less than 25° and it is therefore considered reasonable to assume that the measured stresses are close in value to the principal stresses.

The FLAC modelling carried out to simulate the behaviour of the backfill in the laboratory test demonstrated that, when a softer material is placed between two stiffer platens, the vertical stress profile has a plateau around the centre of the specimen. The stresses drop off towards the edges of the soft material (Figure 6.2). This characteristic behaviour was also noted for backfill material modelled with Mohr-Coulomb behaviour(Figure 6.3).

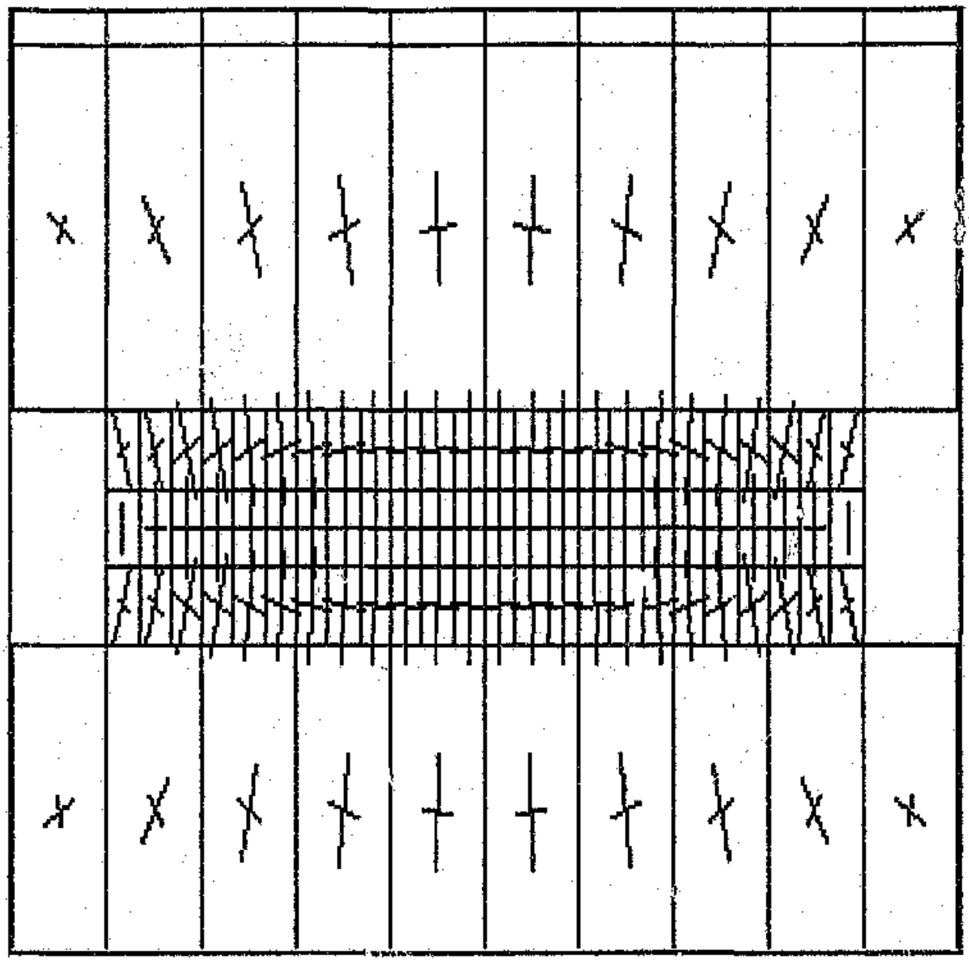

Figure 6.2 Plot of FLAC grid simulating the laboratory tests and showing the magnitude and trajectories of two principal stresses. The contacts between the platens and the backfill sample are allowed to slip and separate. The backfill is modelled as elastic.

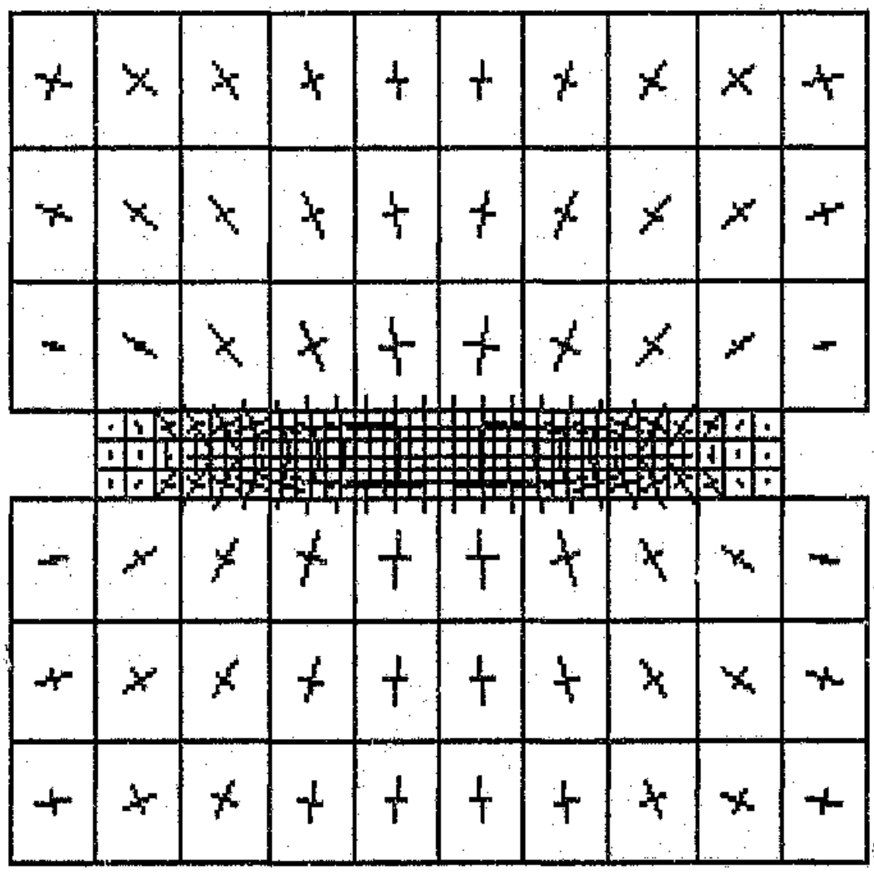

Figure 6.3 Plot of FLAC grid simulating the laboratory tests and showing the magnitude and trajectories of two principal stresses. The contacts between the platens and the backfill sample are allowed to slip and separate. The backfill material is modelled by a Mohr-Coulomb failure criterion.

7 EVALUATION OF RESULTS

The above presentation of the results of investigations into the in situ behaviour dealt with one backfill measuring site at a time. The emphasis was also on the stress distribution in real time, although constant strain stress profiles were shown. In order to compare the in situ results with the laboratory tests, the stresses at all in situ stations in a particular backfill type were plotted at equal strains. The station positions were plotted relative to the backfill rib centre in which each station was located. The plot that results is a composite plot of all stations in a particular backfill type rather than a single dip profile.

The stress profile from the laboratory test, presented in Figure 5.12 is similar to profiles of constant strain which have been drawn up for all stations that were installed in a particular backfill type underground. The in situ data from all three backfill types displayed a similar profile, with stresses having the largest value at the centre of a bag and generally becoming smaller towards the bag's edge. Figure 7.1 shows the profile obtained from all the classified stations installed on one mine. Similar comminuted backfill and dewatered backfill profiles have been shown to occur by Adams and Gürtunca (1991) and Gürtunca and Adams (1991a), respectively, and are shown in Figures 7.2 and 7.3.

The implication of these typical profiles is that the dilation of the backfill is least and possibly zero at the centre of a rib and increases outwards. Even though the dilation becomes small a short way into the backfill, it appears to influence the confinement which greatly affects the load carrying ability of the backfill.

If the stresses are normalised in terms of strain, the results of the laboratory experiment agreed well with stresses which are developed across a backfill rib underground.

A similar stress profile emerges from the numerical models which simulates an unconfined backfill sample. The stress profile reaches a maximum at the centre of the backfill sample and decreases towards the edges. The behaviour of the platens in the numerical models was similar to that of the press in which the backfill was compressed. It is assumed that the platens in both cases remained parallel to each other although, in fact, slight flexing of the platens would have occurred with increasing resistance of the backfill.

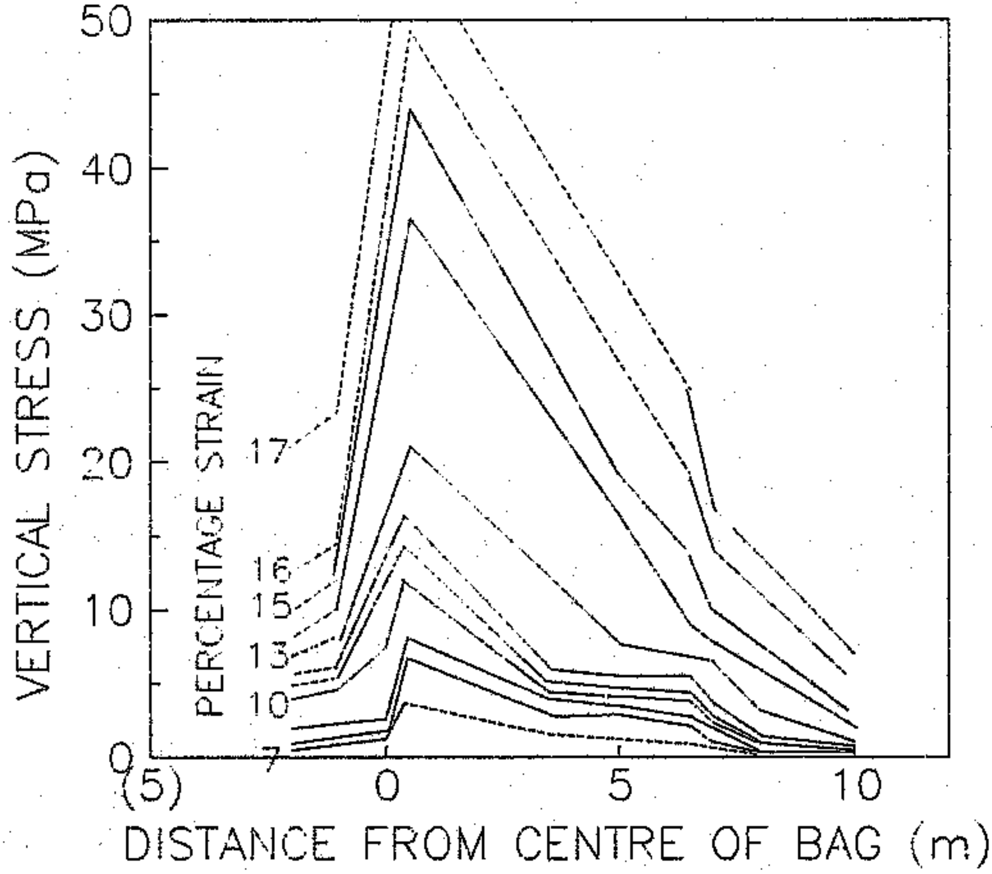

Figure 7.1 Figure showing contours of constant strain and the stresses measured at all stations installed in classified tailings backfill relative to the backfill rib centre

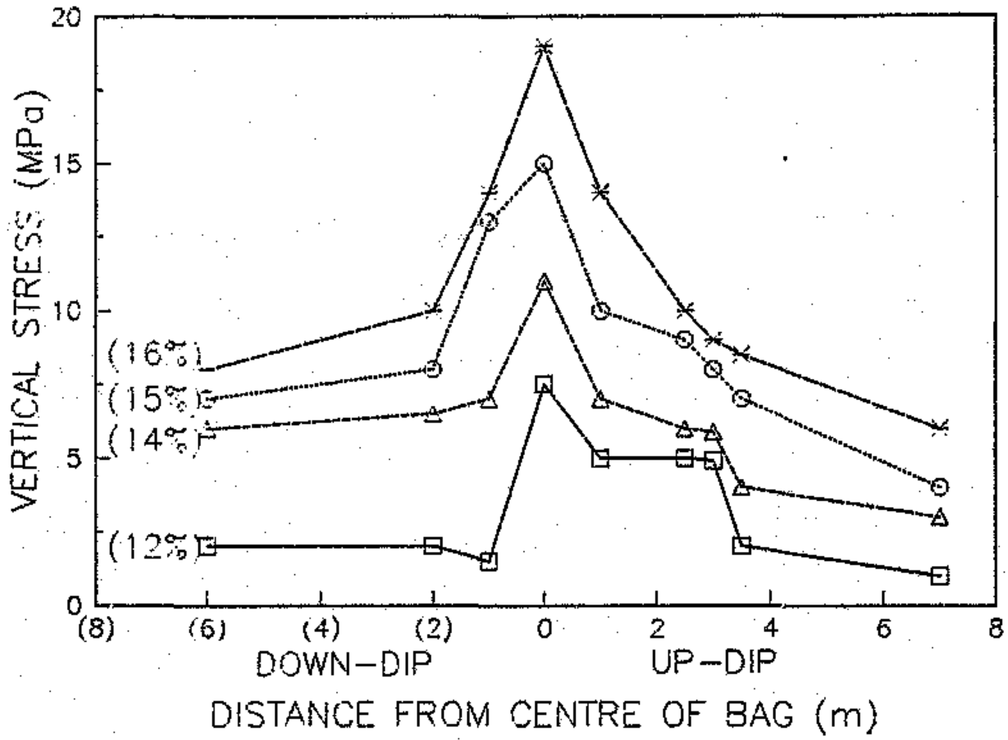

Figure 7.2 Plot of the stresses recorded at all stations installed in dewatered tailings with the station positions plotted relative to the centre of the backfill rib (after Gürtunca and Adams, 1991)

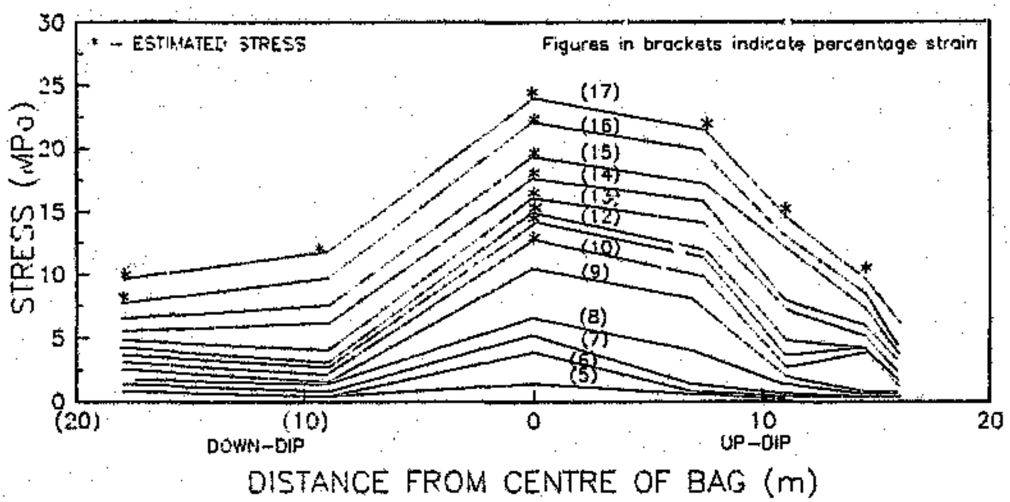

Figure 7.3 **Lines of constant strain for all stations installed in comminuted backfill in terms of the stress at various stations plotted relative to the centre of the backfill rib**

The three dimensional in situ performance of three uncemented backfill types was measured, and the results presented. As indicated previously, two different approaches have been used to present the stress results, namely, daily vertical stress profiles and equal strain vertical stress profiles.

It is clear from the results that different profiles emerge if the stresses in the backfill are plotted in terms of strain and in terms of time. If stopes closed as parallel sided openings, as is the case with the samples tested in the laboratory between two rigid parallel platens, then it would be meaningful to only establish the stress profile in the backfill at constant strain. In this case, purely elastic numerical models could accurately predict the backfill behaviour and the effects of the backfill on closures and stress generation in the backfill and surrounding mass.

Numerical models with elastic constants were used in this dissertation but only to arrive at stress profiles at constant strain and to determine principal stress trajectories which are similar in elastic or inelastic models.

Underground the situation is very different and much more complex than that simulated in the laboratory press. Throughout the stope, closures and closure rates vary. The rock is not elastic and does not behave predictably. The presence of backfill in the stope complicates the closure contours further, by offering variable resistance to closure according to the stress being generated in the backfill.

It is useful to know the daily closure which takes place in a backfilled stope if correct and meaningful stress distributions around backfill stopes are required. A correct assessment of the stress distribution around a backfilled stope is critical to establishing the contribution of backfill to reducing stresses in the surrounding rock which is being mined or in pillars which have been left for stability purposes.

The data suggest that closures across a backfill rib are initially rapid right across the rib, while reaction stresses generated in the backfill due to loading are low. Once the stresses reach approximately 2-3 MPa the closure rates drop. This change in closure rate occurs at 30-50 days and 100-120 mm of closure. In the initial rapid period of closure, the stations closest to the edge of the backfill show the most rapid closure. Once the rate of closure slows, the slope of the closure curves at all stations is similar and often the magnitudes of closure at all stations are close.

The daily vertical stress profiles display the actual vertical stress distribution in a backfilled rib for a particular mining layout. With the aid of such data it is then possible to calibrate a numerical model so that similar results are obtained in the modelled backfill. This will mainly involve building a constitutive model for the backfill behaviour. The correct simulation of the backfill's behaviour has the greatest direct influence on the final stress distribution in the rock mass, rather than whether the rock is modelled elastically or inelastically.

The results from all underground sites reveal that maximum vertical stress occurs at about 1-3 m from the edge of the bag due to increasing closures towards the edge of the backfill. Since the backfill dilates significantly near the backfill edge and also drains more rapidly, and may possess a lower porosity, the stresses drop markedly from the position where the maxima are recorded towards the backfill edge. The stresses at the edge of the bag should be zero but the presence of geotextile bags, paddock planks and packs installed next to the backfill provides limited confinement and allows some stress generation. The location where the maximum vertical stresses are measured is defined as the transition point. The backfill changes its behaviour from confined compression to dilation at this point.

Between the transition point and the centre of the bag, the magnitudes of vertical stresses are determined only by the stoping width and the closure. This is because the backfill is in confined compression in this region and the lateral movements in the backfill are small, relative to the closure.

The presentation of in situ measurements in terms of equal strain is particularly useful for the comparison of in situ and laboratory results. The steel platens do not bend significantly during a backfill rib laboratory test. Therefore, an equal amount of strain is applied throughout the backfill rib in the laboratory test. However, the same effect can be obtained from the in situ measurements by plotting the vertical stresses which occur at equal strain in a backfill bag. Porosities do not vary significantly across the bag except very close to the edge of the backfill and therefore water content changes have a minimal effect. The in situ data presented with respect to equal strain display a different pattern compared with the daily stress measurements. However, the in situ equal strain results (Figures 7.1, 7.2 and 7.3) are very similar to those obtained from the laboratory testing as shown in Figure 5.12. As illustrated in these figures, the maximum vertical stress occurs in the centre of the backfill rib and drops off towards the edge of the bag. However, it should be emphasised once more that the daily stress profiles reflect the real situation in the bag.

From the information discussed above, a schematic three-dimensional diagram has been compiled in Figure 7.4. This is an attempt to provide an impression of the overall stress topography across a backfill rib at a specific time. The stresses at the edge of the backfill are low but usually not zero as a result of the geotextile bag, planks or packs. The stresses increase rapidly up to the transition point where the maximum stresses occur. The location of the transition point is between 1 and 3 m from the backfill edge. As the stiffness of the backfill increases with time as a result of closure, it is expected that the transition point gets closer to the backfill edge. The material is in confined compression between the transition points on opposite sides of the rib and the generation of stress is governed primarily by the stoping width and the closure in this region. The narrower the stoping width and the higher the closure rate, the greater will be the stress.

The above model differs from the model previously proposed by Gürtunca et al. (1989), where the stress distribution across a backfill rib was suggested to be a uniform plateau of high stress.

As seen from the conceptual model described above, the design of any constitutive law for backfill for incorporation into numerical models should allow variable stoping width and stiffness of the backfill across a rib.

The K-ratios in the backfill rib vary between 0,3 and 0,6 for all three backfill types. However, for comminuted waste these values are reached at 7-8 % strain at vertical stresses of 3-4 MPa, for dewatered tailings they are reached at about 14 % with vertical stresses of 6-7 MPa, and in classified tailings they are achieved at 20 % strain at 8-11 MPa vertical stress. This final value of constant K-ratio is defined as the K_0 ratio. The constant K_0 ratio means that the increase in horizontal and vertical stresses is in the same proportion. This also implies that the lateral displacements in the backfill are zero or very small. The stiffer the backfill material, the quicker it experiences K_0 loading conditions.

The comparison between the laboratory and in situ classified tailings K-ratios indicates a similar qualitative behaviour. The laboratory K-ratios also vary between 0,3 and 0,6 after about 25 % strain in the backfill rib.

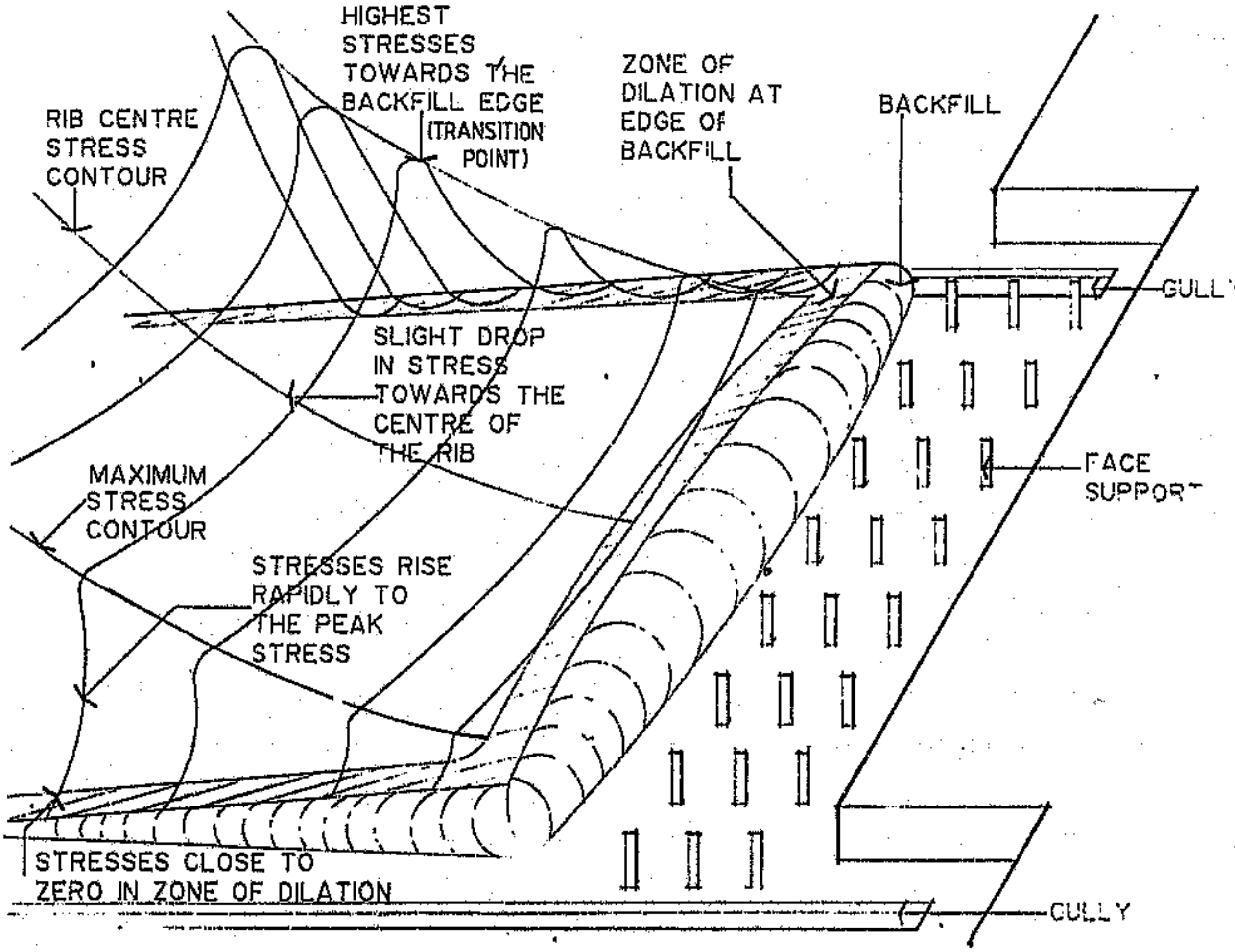

Figure 7.4 A schematic three-dimensional drawing indicating the vertical stresses topography of a backfill rib at a specific time.

The objective of this dissertation has been to present the results obtained from the in situ measurements with a view to describing backfill behaviour underground in three dimensions. The stress generation in the backfill with respect to a position in a bag or paddock is better understood because of the work undertaken for this dissertation. This information can be used to develop and calibrate constitutive models for backfill, to be used in numerical models. Once these models have been teste.. and proven, they can be used to derive design criteria for the use of backfill as regional and local support.

In addition, the results of two laboratory tests, which were carried out to simulate the in situ behaviour of backfill, have been compared to the measurements obtained from underground sites. The laboratory simulations realistically portray the stress distribution underground if stresses are plotted in terms of constant strains.

Laboratory work has shown that stress measurements underground in the backfill will only vary by 5 % from a principal stress if the stress cell is inlined at less than 25° to the principal plane on which the stress is acting. This fact will be useful for researchers collecting data for the considerable work which still has to be carried out in situ with other types of backfills, particularly cemented backfills. With this information it is not necessary to measure shear stresses in order to obtain the full state of stress in the backfill.

The use of laboratory and numerical modelling in verifying the in situ three-dimensional behaviour of three uncemented backfill types has been demonstrated. Although the laboratory and numerical modelling were not excessively complex, the exercise confirmed the performance observed underground.

Even elastic models can be useful in determining some aspects of backfill performance and the stress regime in the rock mass surrounding the backfill, although much more information will be derived from numerical models which include a constitutive law to correctly describe th ackfill behaviour.

Laboratory work has shown that the stress cells themselves do not influence the stress field to a significant extent. They do not act as soft inclusions in the fill which modify the field stress locally but measure the general field stress sufficiently accurately.

8 APPLICATION

The in situ measurements which have been collected during the field experiment and which have been referred to in this dissertation form a data base. These data have not been exhaustively or rigorously handled and it is certain that other researchers may use this data to discover other aspects of the backfill performance not dealt with in this dissertation. Currently, research is taking place into the performance of cemented tailings backfills on South African gold mines and the data collected from the three types of uncemented backfills, documented in this dissertation, will provide a benchmark against which the cemented backfill behaviour can be measured. It is also likely that other types of backfills will be tested underground in the future. These may be composite fills made up of mixtures of crushed rock and plant tailings or tailings with specially designed admixtures added to them for rapid hardening. The data collected from the uncemented backfills will form a basis for evaluating these other backfill types.

The underground backfill monitoring programme has been valuable in collecting data related to the many aspects of the backfill performance. Many of these parameters were not included in the laboratory or numerical modelling carried out for this dissertation. However, it is clear that such information can be used in future laboratory tests and numerical models to assist in the design of new mines and layouts incorporating backfill.

It may be possible to formulate a constitutive model which is able to simulate the stress-strain performance of the different backfills from the data that have been collected. The use of such a law in the numerical models will assist in more accurately simulating the conditions in different mining layouts and thus result in safer and possibly more profitable mines.

The accurate measurement of the various backfill's contribution to carrying stress has resulted in a reassessment of the elastic models and in particular the elastic constants in those programs used in the South African mining industry (Gürtunca and Adams, 1991b). The results contained in this document confirm that high stresses are carried by backfills sooner than predicted by elastic numerical models which are still the only practical models available for modelling regional mine layouts. By using this evidence it is possible to calibrate numerical models correctly and thus obtain the actual contribution which backfill is making towards the alleviation of stress on the working faces and stabilising pillars. This may result in savings to a mine as pillars may be able to be cut smaller if the backfill is carrying more load.

9 CONCLUSIONS

The results of an underground monitoring programme to determine the in situ behaviour of backfills have been presented in this dissertation. The underground results are supported by laboratory and numerical modelling, and the most pertinent conclusions reached from the results are as follows:

(1) on a daily basis highest stresses are expected near but not at the edge of the backfill rib. The stresses drop slightly towards the centre of the rib and fall significantly towards the edge of the rib;

(2) stresses build up in backfill even if no mining takes place in the panel in which instrumented backfill is placed, suggesting that there is a component of time dependent closure in stopes;

(3) closures are rapid throughout a backfill rib for the first 30-50 days and 100-120 mm of closure. The rate of closure slows down after this period and closure;

(4) the initial 50 days of closure of a backfill rib is most rapid close to the edge and slowest towards the centre of the rib;

(5) the agreement between laboratory and in situ measurements is good when they are compared with respect to equal strains;

(6) confinement of the backfill decreases outwards until a zone of 1-3 m from the backfill edge where little or no stress is measured unless confined by a pack, barricade or geotextile fabric;

(7) the K-ratios are generally constant in the range 0,3 to 0,6. They indicate K_0 loading conditions within this band and, as the backfill material becomes stiffer, the K_0 conditions occur sooner during the loading of backfill material;

(8) the presence of stress cells in the backfill do not modify the stress regime to any significant extent;

(9) stress cells may be inclined up to 25° to a principal stress plane and measure a decrease in stress from the principal stress of only 5 %; and

(10) principal stress trajectories, according to simple elastic numerical models, act close to vertical irrespective of the dip of the reef up to 25°; therefore the stresses measured are probably within 5 % of the principal stress magnitude.

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11 APPENDICES

APPENDIX A

WDSW #

STATION C1

Hydraulic Stress/Meters

DATE	DAYS	F/ADVANCE	VERT	STRIKE	DIP	STRAIN	
08-Jul-87	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21-Jul-87	13.000	1.700	0.000	0.000	0.000	0.057	0.000
28-Jul-87	20.000	3.000	0.060	0.000	0.095	0.101	0.060
31-Jul-87	23.000	4.000	0.150	0.045	0.210	0.108	0.105
04-Aug-87	27.000	4.000	0.230	0.075	0.400	0.111	0.215
07-Aug-87	30.000	4.700	0.350	0.080	0.460	0.114	0.270
11-Aug-87	34.500	4.700	0.420	0.110	0.540	0.116	0.310
13-Aug-87	36.000	5.200	0.450	0.120	0.580	0.118	0.330
14-Aug-87	37.000	6.200	0.520	0.150	0.660	0.120	0.370
17-Aug-87	40.000	6.200	0.660	0.200	0.850	0.122	0.460
18-Aug-87	41.000	6.200	0.740	0.250	0.980	0.123	0.490
22-Aug-87	45.000	6.200	0.880	0.300	1.000	0.129	0.580
24-Aug-87	47.000	6.200	0.950	0.350	1.200	0.131	0.600
25-Aug-87	48.000	7.200	1.000	0.400	1.300	0.132	0.600
28-Aug-87	51.000	7.200	1.200	0.480	1.400	0.132	0.720
31-Aug-87	54.000	7.200	1.300	0.570	1.600	0.133	0.730
01-Sep-87	55.000	7.200	1.350	0.580	1.650	0.133	0.770
02-Sep-87	56.000	7.200	1.450	0.600	1.700	0.134	0.850
05-Sep-87	59.000	7.200	1.500	0.630	1.750	0.135	0.870
07-Sep-87	61.000	7.700	1.800	0.680	1.900	0.136	1.120
11-Sep-87	65.000	8.500	2.200	0.850	2.200	0.140	1.350
22-Sep-87	76.000	9.000	2.500	1.000	2.600	0.142	1.500
29-Sep-87	83.000	9.700	2.700	1.200	2.900	0.148	1.500
03-Oct-87	87.000	11.400	3.150	1.500	3.100	0.149	1.650
09-Oct-87	93.000	12.700	3.800	1.800	3.550	0.150	2.000
14-Oct-87	98.000	13.300	4.100	2.500	3.850	0.152	1.600
21-Oct-87	105.000	15.700	4.100	3.000	3.950	0.155	1.100
23-Oct-87	107.000	15.700	4.500	3.400	4.200	0.155	1.100
27-Oct-87	111.000	16.300	4.700	3.600	4.400	0.156	1.100
02-Nov-87	117.000	16.300	EOF	4.000	4.400	0.161	
11-Nov-87	126.000	16.300		4.300	4.400	0.163	
16-Nov-87	131.000	17.400		4.600	4.800	0.164	
23-Nov-87	138.000	18.700		5.200	5.000	0.166	
30-Nov-87	145.000	18.700		5.800	5.700	0.169	
03-Dec-87	148.000	20.700		6.200	6.000	0.171	
08-Dec-87	153.000	20.700		7.000	6.900	0.172	
11-Dec-87	156.000	20.700		7.300	7.000	0.174	
18-Dec-87	163.000	22.500		7.700	7.500	0.176	
22-Dec-87	167.000	23.300		8.000	7.800	0.177	
24-Dec-87	169.000	23.300		8.300	8.000	0.179	
30-Dec-87	175.000	23.300		8.500	8.400	0.181	
05-Jan-88	181.000	23.300		8.500	8.500	0.182	
08-Jan-88	184.000	23.700		9.000	9.000	0.183	
14-Jan-88	190.000	23.700		9.500	9.500	0.183	
20-Jan-88	196.000	24.700		9.800	10.000	0.186	
25-Jan-88	201.000	24.700		10.000	10.000	0.188	
27-Jan-88	203.000	24.700		10.000	10.500	0.189	
03-Feb-88	210.000	25.700		10.000	11.000	0.189	
08-Feb-88	215.000	26.300		10.500	11.500	0.191	
16-Feb-88	223.000	27.700	EOF	11.500	12.000	0.192	
23-Feb-88	230.000	27.700		12.000	13.000	0.199	
03-Mar-88	239.000	27.700		13.000	14.000	0.199	
09-Mar-88	245.000	29.200		14.000	15.000	0.204	

16-Mar-88	252.000	30.700		15.000	16.000	0.209
21-Mar-88	257.000	31.700		16.000	17.000	0.212
28-Mar-88	264.000	33.200		17.000	18.000	0.219
05-Apr-88	272.000	34.200		18.000	19.000	0.224
11-Apr-88	278.000	35.200		19.000	20.000	0.231
20-Apr-88	287.000	35.200		19.500	20.500	0.234
27-Apr-88	294.000	37.700		20.000	21.800	0.235
02-May-88	299.000	39.200		21.000	23.000	0.237
09-May-88	306.000	39.700		22.000	24.000	0.240
14-May-88	311.000	39.700		23.500	24.500	0.242
20-May-88	317.000	39.700		25.000	26.000	0.243
25-May-88	322.000	41.000		26.000	26.500	0.244
07-Jun-88	335.000	42.200		27.000	27.000	0.245
14-Jun-88	342.000	43.200		28.500	28.500	0.253
21-Jun-88	349.000	43.200		30.000	30.000	0.256
28-Jun-88	356.000	46.300		31.500	31.500	0.257
06-Jul-88	364.000	46.700	EOF	33.500	33.500	0.258
20-Jul-88	378.000	51.700		37.500	37.000	0.260
01-Aug-88	390.000	51.700		39.000	38.000	0.262
12-Aug-88	401.000	52.700		40.000	39.500	0.262
29-Aug-88	418.000	53.700		44.500	45.000	0.280
07-Sep-88	427.000	53.700		48.000	48.000	0.286
19-Sep-88	439.000	56.700		49.000	48.500	0.286
26-Sep-88	446.000	59.500		50.500	49.500	0.286
03-Oct-88	453.000	61.700		51.500	50.500	0.288
11-Oct-88	461.000	61.700		52.500	52.000	0.288
17-Oct-88	467.000	61.700		54.000	53.000	0.291
03-Nov-88	484.000	61.700		56.000	56.000	0.293
16-Nov-88	497.000	63.000		57.500	57.000	0.295
02-Dec-88	513.000	64.000		59.000	59.000	0.298
08-Dec-88	519.000	68.000		60.500	60.000	0.298
21-Dec-88	532.000	70.000				
04-Jan-89	546.000	71.000				
26-Jan-89	568.000	73.000				
			EOF	EOF	EOF	0.020

WDSW #

	STATION C2								STATION C2			
	Hydraulic Stress/Meters								Glotzl Stress/Meters			

DATE	DAYS	F/ADVANCE	VERT	STRIKE	DIP	STRAIN			VERT	STRIKE	DIP	STRAIN
08-Jul-87	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21-Jul-87	13.000	1.700	0.000	0.000	0.000	0.035	0.000	0.000	0.000	0.000	0.000	0.035
28-Jul-87	20.000	3.000	0.000	0.000	0.000	0.071	0.000	0.000	0.100	0.000	0.000	0.071
31-Jul-87	23.000	4.000	0.060	0.000	0.000	0.080	0.060	0.060	0.260	0.100	0.080	0.080
04-Aug-87	27.000	4.000	0.110	0.000	0.000	0.083	0.110	0.110	0.520	0.120	0.100	0.083
07-Aug-87	30.000	4.700	0.130	0.000	0.000	0.092	0.130	0.130	0.600	0.130	0.120	0.092
11-Aug-87	34.000	4.700	0.160	0.000	0.000	0.093	0.160	0.160	0.640	0.150	0.150	0.093
13-Aug-87	36.000	5.200	0.180	0.000	0.000	0.096	0.180	0.180	0.700	0.160	0.160	0.096
14-Aug-87	37.000	6.200	0.230	0.000	0.000	0.100	0.230	0.230	0.710	0.180	0.180	0.100
17-Aug-87	40.000	6.200	0.310	0.000	0.000	0.103	0.310	0.310	0.700	0.200	0.200	0.103
18-Aug-87	41.000	6.200	0.370	0.000	0.050	0.103	0.370	0.320	0.800	0.220	0.250	0.103
22-Aug-87	45.000	6.200	0.450	0.000	0.060	0.107	0.450	0.390	0.820	0.240	0.280	0.105
24-Aug-87	47.000	6.200	0.530	0.000	0.070	0.107	0.530	0.460	0.880	0.250	0.300	0.107
25-Aug-87	48.000	7.200	0.560	0.020	0.080	0.107	0.540	0.480	1.000	0.350	0.350	0.107
28-Aug-87	51.000	7.200	0.600	0.030	0.090	0.108	0.570	0.510	1.100	0.400	0.380	0.108
31-Aug-87	54.000	7.200	0.650	0.040	0.120	0.108	0.610	0.530	1.150	0.400	0.400	0.109
01-Sep-87	55.000	7.200	0.740	0.050	0.130	0.110	0.690	0.610	1.200	0.450	0.450	0.110
02-Sep-87	56.000	7.200	0.770	0.060	0.140	0.110	0.710	0.630	1.250	0.500	0.500	0.111
05-Sep-87	59.000	7.200	0.780	0.060	0.160	0.111	0.720	0.620	1.300	0.500	0.500	0.112
07-Sep-87	61.000	7.700	0.840	0.060	0.180	0.111	0.780	0.660	1.400	0.600	0.500	0.115
11-Sep-87	65.000	8.500	1.000	0.080	0.190	0.112	0.920	0.810	1.700	0.600	0.500	0.120
22-Sep-87	76.000	9.000	1.100	0.100	0.240	0.115	1.000	0.860	1.800	0.700	0.650	0.115
29-Sep-87	83.000	9.700	1.300	0.120	0.270	0.120	1.180	1.030	1.900	0.750	0.750	0.120
03-Oct-87	87.000	11.400	1.450	0.140	0.320	0.123	1.310	1.130	2.000	0.800	0.900	0.123
09-Oct-87	93.000	12.700	1.550	0.180	0.380	0.124	1.370	1.170	2.200	0.930	0.950	0.124
14-Oct-87	98.000	13.300	1.800	0.200	0.450	0.125	1.600	1.350	2.400	1.000	1.200	0.125
21-Oct-87	105.000	15.700	1.900	0.230	0.550	0.128	1.670	1.350	2.500	1.500	EOF	0.129
23-Oct-87	107.000	15.700	2.000	0.270	0.600	0.129	1.730	1.400	2.700	1.700		0.130
27-Oct-87	111.000	16.300	2.150	0.280	0.650	0.130	1.870	1.500	2.800	2.000		0.134
02-Nov-87	117.000	16.300	2.500	0.350	0.700	0.131	2.150	1.800	3.200	2.500		0.133
11-Nov-87	126.000	16.300	2.600	0.440	0.730	0.134	2.160	1.870	3.800	3.000		0.134
16-Nov-87	131.000	17.400	2.900	0.530	0.900	0.136	2.370	2.000	4.200	3.200		0.140
23-Nov-87	138.000	18.700	3.250	0.700	1.050	0.136	2.550	2.200	4.400	3.400		0.136
30-Nov-87	145.000	18.700	3.400	0.900	1.200	0.138	2.500	2.200	5.800	3.500		0.138
03-Dec-87	148.000	20.700	3.500	0.900	1.300	0.139	2.600	2.200	6.200	3.800		0.139
08-Dec-87	153.000	20.700	4.000	1.000	1.400	0.140	3.000	2.600	6.600	3.900		0.140
11-Dec-87	156.000	20.700	4.100	1.000	1.450	0.140	3.100	2.650	6.800	4.000		0.140
18-Dec-87	162.000	22.500	4.300	1.100	1.500	0.141	3.200	2.800	7.200	4.100		0.141
22-Dec-87	167.000	23.300	4.500	1.150	1.600	0.142	3.350	2.900	7.400	4.100		0.142
24-Dec-87	169.000	23.300	4.600	1.250	1.650	0.143	3.350	2.950	8.000	4.200		0.143
30-Dec-87	175.000	23.300	4.700	1.300	1.700	0.143	3.400	3.000	8.500	4.300		0.144
05-Jan-88	181.000	23.300	4.750	1.350	1.750	0.144	3.400	3.000	9.000	4.400		0.144
08-Jan-88	184.000	23.700	4.800	1.400	1.800	0.145	3.400	3.000	9.000	4.500		0.145
14-Jan-88	190.000	23.700	5.000	1.550	1.900	0.147	3.450	3.100	9.200	4.600		0.147
20-Jan-88	196.000	24.700	5.300	1.600	1.900	0.148	3.700	3.400	9.300	4.600		0.148
25-Jan-88	201.000	24.700	5.600	1.650	2.050	0.148	3.950	3.550	9.400	4.700		0.148
27-Jan-88	203.000	24.700	6.000	1.700	2.100	0.149	4.300	3.900	9.500	4.800	EOF	0.149
03-Feb-88	210.000	25.700	6.000	1.800	2.200	0.149	4.200	3.800	9.500	4.800		0.149
08-Feb-88	215.000	26.500	6.300	1.900	2.400	0.150	4.400	3.900	10.000	5.000		0.150
16-Feb-88	223.000	27.700	6.500	2.000	2.500	0.151	4.500	4.000	10.500	5.200		0.152
23-Feb-88	230.000	27.700	6.800	2.100	2.600	0.152	4.700	4.200	11.000	5.300		0.152
03-Mar-88	239.000	27.700	7.000	2.300	2.700	0.152	4.700	4.300	11.500	5.500		0.155
09-Mar-88	245.000	29.200	7.300	2.500	2.900	0.152	4.800	4.400	12.800	5.800		0.158

16-Mar-88	252.000	30.700	7.500	2.700	3.100	0.155	4.800	4.400	14.200	6.000		0.183
21-Mar-88	257.000	31.700	8.000	3.000	3.300	0.158	5.000	4.700	16.000	6.500		0.167
28-Mar-88	264.000	33.200	8.300	3.100	3.400	0.163	5.200	4.900	17.600	7.000		0.174
05-Apr-88	272.000	34.200	8.500	3.200	3.150	0.167	5.300	5.350	19.800	7.500		0.174
11-Apr-88	278.000	35.200	8.700	3.300	3.600	0.171	5.400	5.100	21.200	7.600		0.174
20-Apr-88	287.000	35.200	9.000	3.500	3.700	0.173	5.500	5.300	23.000	7.800		0.175
27-Apr-88	294.000	37.700	9.500	3.700	3.900	0.174	5.800	5.600	24.000	7.900		0.175
02-May-88	299.000	39.200	10.000	3.900	4.100	0.178	6.100	5.900	25.000	8.000		0.176
09-May-88	306.000	39.700	10.100	4.000		0.180	6.100		26.000	8.500		0.178
14-May-88	311.000	39.700	10.300	EOF	EOF	0.180			27.000	9.000		0.179
20-May-88	317.000	39.700	10.500			0.180			29.000	10.000		0.180
25-May-88	322.000	41.000	10.800			0.180			30.000	10.500		0.184
07-Jun-88	335.000	42.200	11.000			0.187			32.500	11.000		0.187
14-Jun-88	342.000	43.200	11.000			0.189			EOF	EOF	EOF	EOF
21-Jun-88	349.000	43.200	11.500			0.190						
28-Jun-88	356.000	46.300	12.000			0.191						
06-Jul-88	364.000	46.700	13.000			0.192						
20-Jul-88	378.000	51.700	14.000			0.195						
01-Aug-88	390.000	51.700	14.200			0.198						
12-Aug-88	401.000	52.700	14.800			0.212						
29-Aug-88	418.000	53.700	15.500			0.213						
07-Sep-88	427.000	53.700	16.000			0.213						
19-Sep-88	439.000	56.700	16.000			0.213						
26-Sep-88	446.000	59.500	16.200			0.214						
03-Oct-88	453.000	61.700	16.500			0.214						
11-Oct-88	461.000	61.700	17.000			0.217						
17-Oct-88	467.000	61.700	17.500			0.219						
03-Nov-88	484.000	61.700	18.000			0.221						
16-Nov-88	497.000	63.000	18.500			0.220						
02-Dec-88	513.000	64.000	19.000	EOF	EOF	0.226						
08-Dec-88	519.000	68.000	19.000			0.229						
21-Dec-88	532.000	70.000	19.500			0.226						
04-Jan-89	546.000	71.000	20.000			0.230						
26-Jan-89	568.000	[illegible]	20.500			0.233						
			EOF	EOF	EOF	0.020			EOF	EOF	EOF	EOF

WD5W #	STATION C3 Maritz Stress/Meters						STATION C3 Hydraulic Stress/Meters				
DATE	DAYS	F/ADVANCE	VERT	STRIKE	DIP	STRAIN	VERT	STRIKE	DIP	STRAIN	
08-Jul-87	0.000	0.000	0.000	EOF	EOF	0.000	0.000	EOF	0.000	0.000	0.000
21-Jul-87	13.000	1.700	0.000			0.028	0.000		0.000	0.028	0.000
28-Jul-87	20.000	3.000	0.000			0.050	0.000		0.000	0.050	0.000
31-Jul-87	23.000	4.000	0.135			0.062	0.200		0.000	0.062	0.200
04-Aug-87	27.000	4.000	0.180			0.076	0.370		0.000	0.076	0.370
07-Aug-87	30.000	4.700	0.250			0.078	0.450		0.000	0.078	0.450
11-Aug-87	34.000	4.700	0.450			0.087	0.550		0.000	0.087	0.550
13-Aug-87	36.000	5.200	0.460			0.087	0.730		0.000	0.087	0.730
14-Aug-87	37.000	6.200	0.480			0.090	0.900		0.000	0.090	0.900
17-Aug-87	40.000	6.200	0.480			0.090	1.000		0.000	0.093	1.000
18-Aug-87	41.000	6.200	0.500			0.093	1.150		0.000	0.095	1.150
22-Aug-87	45.000	6.200	0.700			0.095	1.200		0.000	0.095	1.200
24-Aug-87	47.000	6.200	0.900			0.097	1.300		0.000	0.097	1.300
25-Aug-87	48.000	7.200	1.000			0.100	1.300		0.000	0.100	1.300
28-Aug-87	51.000	7.200	1.100			0.100	1.400		0.000	0.104	1.400
31-Aug-87	54.000	7.200	1.100			0.110	1.500		0.000	0.108	1.500
01-Sep-87	55.000	7.200	1.200			0.115	1.600		0.000	0.109	1.600
02-Sep-87	56.000	7.200	1.300			0.118	1.650		0.100	0.113	1.550
05-Sep-87	59.000	7.200	1.400			0.120	1.700		0.150	0.114	1.550
07-Sep-87	61.000	7.700	1.400			0.120	1.750		0.200	0.115	1.550
11-Sep-87	65.000	8.500	1.500	EOF	EOF	0.120	1.900	EOF	0.300	0.115	1.600
22-Sep-87	76.000	9.000	1.600			0.120	2.200		0.400	0.118	1.800
29-Sep-87	83.000	9.700	1.800			0.122	2.450		0.500	0.124	1.950
03-Oct-87	87.000	11.400	2.000			0.125	2.700		0.600	0.124	2.100
09-Oct-87	93.000	12.700	2.100			0.126	3.000		0.650	0.125	2.350
14-Oct-87	98.000	13.300	2.100			0.129	3.200		0.700	0.126	2.500
21-Oct-87	105.000	15.700	2.400			0.129	3.300		0.800	0.129	2.500
23-Oct-87	107.000	15.700	2.500			0.129	3.650		0.900	0.130	2.750
27-Oct-87	111.000	16.300	2.600			0.130	3.800		1.000	0.131	2.800
02-Nov-87	117.000	16.300	2.600			0.130	3.900		1.200	0.131	2.700
11-Nov-87	126.000	16.300	2.700			0.131	4.000		1.400	0.132	2.600
16-Nov-87	131.000	17.400	2.800			0.132	4.100		1.500	0.132	2.600
23-Nov-87	138.000	18.700	3.000			0.133	4.200		1.600	0.133	2.600
30-Nov-87	145.000	18.700	3.600			0.135	4.300		1.800	0.135	2.500
03-Dec-87	148.000	20.700	3.800			0.135	4.800		1.900	0.136	2.900
08-Dec-87	153.000	20.700	4.000			0.136	5.000		2.000	0.136	3.000
11-Dec-87	156.000	20.700	4.500			0.137	5.100		2.100	0.137	3.000
18-Dec-87	163.000	22.500	5.000			0.138	5.400		2.100	0.137	3.300
22-Dec-87	167.000	23.300	6.000			0.138	5.500		2.100	0.138	3.400
24-Dec-87	169.000	23.300	6.500			0.139	5.700		2.100	0.139	3.600
30-Dec-87	175.000	23.300	7.000	EOF	EOF	0.140	5.900	EOF	2.200	0.140	3.700
05-Jan-88	181.000	23.300	8.000			0.140	6.000		2.300	0.140	3.700
08-Jan-88	184.000	23.700	9.000			0.143	6.400		2.400	0.143	4.000
14-Jan-88	190.000	23.700	10.000			0.144	6.600		2.500	0.144	4.100
20-Jan-88	196.000	24.700	11.000			0.145	6.900		2.600	0.145	4.300
25-Jan-88	201.000	24.700	11.400			0.146	7.000		2.700	0.146	4.300
27-Jan-88	203.000	24.700	11.800			0.146	7.100		2.700	0.147	4.400
03-Feb-88	210.000	25.700	12.000			0.147	7.400		2.800	0.147	4.600
08-Feb-88	215.000	26.500	12.200			0.150	8.000		3.000	0.149	5.000
16-Feb-88	223.000	27.700	12.500			0.150	8.300		3.200	0.149	5.100
23-Feb-88	230.000	27.700	12.800			0.150	8.500		3.400	0.150	5.100
03-Mar-88	239.000	27.700	12.900			0.150	9.000		3.500	0.150	5.500
09-Mar-88	245.000	29.200	13.000			0.156	9.500		3.700	0.155	5.800

16-Mar-88	252.000	30.700	13.500			0.160	10.000		3.900	0.160	6.100
21-Mar-88	257.000	31.700	13.800			0.162	10.500		4.000	0.162	6.500
28-Mar-88	264.000	33.200	14.000			0.170	10.800		4.200	0.168	6.600
05-Apr-88	272.000	34.200	14.300			0.172	11.000		4.500	0.172	6.500
11-Apr-88	278.000	35.200	14.500			0.175	11.500		4.600	0.177	6.900
20-Apr-88	287.000	35.200	15.000			0.180	12.000		4.700	0.180	7.300
27-Apr-88	294.000	37.700	16.000			0.181	12.500		5.000	0.181	7.500
02-May-88	299.000	39.200	[illegible]	EOF	EOF	0.182	13.000	EOF	5.300	0.182	7.700
09-May-88	306.000	39.700	17.200			0.185	13.500		5.600	0.185	7.900
14-May-88	311.000	39.700	17.500			0.187	14.000		5.800	0.187	8.200
20-May-88	317.000	39.700	17.600			0.188	14.500		6.000	0.187	8.500
25-May-88	322.000	41.000	17.800			0.188	14.800	EOF	EOF	0.190	
07-Jun-88	335.000	42.200	18.000			0.195	15.000			0.195	
14-Jun-88	342.000	43.200	18.500			0.196	15.500			0.196	
21-Jun-88	349.000	43.200	18.700			0.199	16.000			0.200	
28-Jun-88	356.000	46.300	19.000			0.200	17.000			0.200	
06-Jul-88	364.000	46.700	EOF	EOF	EOF	EOF	18.000			0.204	
20-Jul-88	378.000	51.700					18.500			0.204	
01-Aug-88	390.000	51.700					19.000			0.210	
12-Aug-88	401.000	52.700					19.500			[illegible]	
29-Aug-88	418.000	53.700					20.500			0.223	
07-Sep-88	427.000	53.700					21.500			0.224	
19-Sep-88	439.000	56.700					21.600			0.225	
26-Sep-88	446.000	59.500					21.800			0.228	
03-Oct-88	453.000	61.700					22.000			0.230	
11-Oct-88	461.000	61.700					22.500			0.232	
17-Oct-88	467.000	61.700					23.000			0.228	
03-Nov-88	484.000	61.700					24.000			0.230	
16-Nov-88	497.000	63.000					24.500			0.232	
02-Dec-88	513.000	64.000					24.800			0.233	
08-Dec-88	519.000	68.000					25.000			0.234	
21-Dec-88	532.000	70.000					25.500	EOF	EOF	0.239	
04-Jan-89	546.000	71.000					26.000			0.241	
26-Jan-89	568.000	73.000					27.500			0.245	
			EOF	EOF	EOF	0.020	EOF	EOF	EOF	EOF	

				STATIONB1			WD GLOTZL	
				Maritz S/Meter				
DATE	DAYS	F/ADV	VERT	STRIKE	DIP	STRAIN	VERT	STRAIN
10-Dec-86	0.00	0.0	0.0	0.0	0.0	0.000	0.0	0.00
13-Dec-86	3.00	1.0	0.0	0.0	0.0	0.000	0.0	0.00
17-Dec-86	7.00	1.5	0.0	0.0	0.0	0.000	0.0	0.00
19-Dec-86	9.00	2.0	0.1	0.0	0.0	0.000	0.1	0.00
22-Dec-86	12.00	2.5	0.1	0.0	0.0	0.000	0.1	0.00
29-Dec-86	19.00	3.5	0.1	0.0	0.0	0.000	0.1	0.00
30-Dec-86	20.00	4.0	0.1	0.0	0.0	0.000	0.1	0.01
31-Dec-86	21.00	4.5	0.1	0.0	0.0	0.000	0.1	0.00
02-Jan-87	23.00	4.5	0.1	0.1	0.0	0.008	0.1	0.01
05-Jan-87	26.00	4.5	0.1	0.1	0.1	0.013	0.2	0.02
07-Jan-87	28.00	4.5	0.1	0.1	0.1	0.017	0.2	0.02
14-Jan-87	35.00	4.5	0.2	0.1	0.1	0.021	0.3	0.03
19-Jan-87	40.00	5.5	0.2	0.1	0.1	0.025	0.4	0.03
21-Jan-87	42.00	6.5	0.2	0.2	0.2	0.025	0.4	0.03
23-Jan-87	44.00	7.0	0.2	0.3	0.3	0.025	0.4	0.03
[illegible]-87	47.00	7.0	0.2	0.3	0.3	0.025	0.4	0.04
28-Jan-87	49.00	7.3	0.2	0.3	0.3	0.030	0.5	0.04
30-Jan-87	51.00	7.3	0.2	0.4	0.4	0.034	0.5	0.05
02-Feb-87	54.00	8.0	0.2	0.4	0.4	0.038	0.6	0.05
07-Feb-87	59.00	8.0	0.3	0.4	0.4	0.042	0.7	0.06
09-Feb-87	61.00	9.0	0.3	0.5	0.5	0.047	0.7	0.06
11-Feb-87	63.00	9.0	0.4	0.6	0.6	0.051	0.8	0.06
13-Feb-87	65.00	9.5	0.4	0.6	0.6	0.051	0.8	0.06
16-Feb-87	68.00	10.0	0.8	0.7	0.7	0.055	0.8	0.06
[illegible]9-Feb-87	71.00	10.5	0.8	0.7	0.8	0.060	0.9	0.07
[illegible]-Feb-87	72.00	11.0	0.8	0.8	0.8	0.062	1.0	0.07
[illegible]-Feb-87	77.00	12.0	0.9	0.8	0.8	0.064	1.2	0.07
[illegible]-Feb-87	79.00	12.4	0.9	0.8	0.8	0.068	1.2	0.08
[illegible]-Mar-87	83.00	12.4	1.0	0.9	0.9	0.070	1.2	0.08
[illegible]6-Mar-87	86.00	13.0	1.0	0.9	0.9	0.070	1.2	0.08
07-Mar-87	87.00	13.0	1.2	0.9	0.9	0.070	1.8	0.08
10-Mar-87	90.00	13.5	1.5	0.9	1.0	0.070	2.0	0.09
12-Mar-87	92.00	14.0	1.8	0.9	1.0	0.076	2.6	0.09
17-Mar-87	97.00	14.0	1.8	0.9	1.0	0.080	2.6	0.09
18-Mar-87	98.00	14.0	1.8	0.9	1.0	0.080	2.8	0.09
20-Mar-87	100.00	14.0	2.0	1.0	1.0	0.081	3.0	0.09
24-Mar-87	104.00	14.0	2.2	1.0	1.0	0.085	3.0	0.10
30-Mar-87	110.00	14.0	2.5	1.4	1.2	0.090	3.5	0.10
31-Mar-87	111.00	14.0	2.5	1.4	1.3	0.090	3.6	0.10
02-Apr-87	113.00	14.0	2.5	1.4	1.4	0.090	3.8	0.10
04-Apr-87	115.00	14.0	2.5	1.6	1.5	0.090	4.0	0.11
08-Apr-87	119.00	14.0	2.6	1.8	1.8	0.093	4.4	0.11
14-Apr-87	125.00	14.0	3.0	2.0	2.0	0.097	4.4	0.11
21-Apr-87	132.00	14.0	3.1	2.1	2.1	0.102	4.5	0.11
22-Apr-87	133.00	14.5	3.3	2.2	2.4	0.110	4.8	0.12
27-Apr-87	138.00	15.0	3.4	2.4	2.7	0.110	5.0	0.12
29-Apr-87	140.00	15.0	3.6	2.8	2.8	0.110	5.2	0.12
05-May-87	146.00	16.0	3.8	2.8	3.0	0.115	5.4	0.12
07-May-87	148.00	18.0	3.8	2.8	3.0	0.117	5.4	0.12
10-May-87	151.00	19.0	4.0	2.8	3.0	0.118	5.6	0.12
12-May-87	153.00	21.0	4.0	2.8	3.0	0.120	5.8	0.12
14-May-87	155.00	23.0	4.1	2.8	3.0	0.121	5.8	0.12
18-May-87	159.00	24.0	4.2	2.8	3.0	0.123	6.2	0.12
20-May-87	161.00	25.0	4.6	3.0	3.0	0.125	6.4	0.13
22-May-87	163.00	25.0	4.6	3.1	3.1	0.128	6.4	0.13
25-May-87	166.00	26.0	4.8	3.2	3.2	0.130	6.8	0.13
27-May-87	168.00	27.0	5.0	3.3	3.4	0.132	7.0	0.13
30-May-87	171.00	28.0	5.2	3.4	3.4	0.135	7.2	0.14
02-Jun-87	174.00	28.0	5.2	3.5	3.4	0.135	7.4	0.14

05-Jun-87	177.00	28.0	5.4	3.5	3.4	0.135	7.6	0.14
08-Jun-87	180.00	28.0	5.6	3.5	3.4	0.136	7.6	0.14
10-Jun-87	182.00	28.0	5.7	3.5	3.4	0.136	7.8	0.14
12-Jun-87	184.00	28.0	5.8	3.5	3.4	0.136	8.0	0.14
15-Jun-87	187.00	28.0	5.8	3.7	3.4	0.136	8.0	0.14
17-Jun-87	189.00	28.0	5.8	3.7	3.4	0.136	8.0	0.14
22-Jun-87	194.00	28.0	5.8	3.8	3.8	0.141	8.0	0.14
26-Jun-87	198.00	28.0	6.0	4.0	3.8	0.141	8.2	0.14
11-Jul-87	213.00	29.0	6.8	4.0	3.9	0.147	9.0	0.15
13-Jul-87	215.00	30.5	7.2	4.2	4.0	0.151	9.2	0.15
22-Jul-87	224.00	32.0	7.4	4.3	4.0	0.157	9.6	0.16
03-Aug-87	236.00	33.0	8.8	4.4	4.1	0.163	9.8	0.16
07-Aug-87	240.00	35.0	9.6	4.5	4.2	0.165	10.0	0.17
11-Aug-87	244.00	38.0	10.2	4.5	4.4	0.166	10.1	0.17
12-Aug-87	245.00	39.0	10.5	4.5	4.6	0.169	11.0	0.17
18-Aug-87	251.00	40.0	10.6	4.6	4.8	0.171	11.8	0.17
26-Aug-87	259.00	44.0	11.2	4.8	4.8	0.173	12.0	0.17
07-Sep-87	271.00	44.0	11.8	5.4	5.4	0.174	12.2	0.17
14-Sep-87	278.00	45.5	12.0	6.0	6.0	0.175	12.8	0.18
23-Sep-87	287.00	45.5	12.4	6.7	6.7	0.179	13.4	0.18
01-Oct-87	295.00	45.5	12.5	6.8	6.8	0.180	13.6	0.18
12-Oct-87	306.00	45.5	12.9	7.0	7.0	0.180	13.8	0.18
16-Oct-87	310.00	45.5	13.0	7.0	7.0	0.180	14.0	0.18
21-Oct-87	315.00	45.5	13.2	7.1	7.0	0.180	14.0	0.18
29-Oct-87	323.00	45.5	13.4	7.2	7.1	0.180	14.0	0.18
03-Nov-87	328.00	45.5	13.5	7.3	7.2	0.181	14.3	0.18
12-Nov-87	337.00	45.5	13.6	7.4	7.2	0.185	14.5	0.19
19-Nov-87	344.00	45.5	13.9	7.6	7.6	0.186	14.6	0.19
30-Nov-87	355.00	45.5	14.2	7.8	7.8	0.186	14.8	0.19
07-Dec-87	362.00	45.5	14.5	7.9	7.9	0.187	14.8	0.19
15-Dec-87	370.00	45.5	14.5	7.9	7.9	0.187	14.8	0.19
[illegible]2-Dec-87	377.00	45.5	14.5	7.9	8.0	0.187	15.0	0.19
[illegible]-Jan-88	391.00	45.5	14.5	7.9	9.0	0.190	15.8	0.19
[illegible]-Jan-88	397.00	45.5	15.0	8.0	10.0	0.190	16.5	0.19
[illegible]-Jan-88	404.00	45.5	17.0	11.0	11.0	0.190	17.0	0.19
[illegible]-Jan-88	406.00	45.5	17.5	12.0	12.0	0.190	17.0	0.19
[illegible]6-Jan-88	412.00	45.5	18.0	14.0	14.0	0.190	17.0	0.19
08-Feb-88	425.00	45.5	18.5	15.0	15.0	0.191	17.0	0.19
16-Feb-88	433.00	45.5	19.0	15.5	15.5	0.191	17.5	0.19
22-Feb-88	439.00	45.5	19.0	16.0	15.5	0.193	17.5	0.19
03-Mar-88	449.00	45.5	19.0	16.0	16.0	0.195	18.0	0.19
19-Mar-88	465.00	45.5	19.0	16.0	16.0	0.195	18.0	0.20
03-May-88	510.00	45.5	19.0	16.0	16.0	0.195	18.5	0.20
			EOF	EOF	EOF	EOF	EOF	EOF

			STATIONB2				STATIONB3			
			Hydraulic		S/METER		Hydraulic		S/METER	
DATE	DAYS	F/ADV	VERT	STRIKE	DIP	STRAIN	VERT	STRIKE	DIP	STRAIN
10-Dec-86	0.00	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.000
13-Dec-86	3.00	1.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.000
17-Dec-86	7.00	1.5	0.0	0.0	0.0	0.00	0.0	0.1	0.1	0.005
19-Dec-86	9.00	2.0	0.0	0.0	0.0	0.00	0.0	0.1	0.1	0.006
22-Dec-86	12.00	2.5	0.0	0.0	0.0	0.00	0.0	0.1	0.1	0.008
29-Dec-86	19.00	3.5	0.0	0.0	0.0	0.00	0.0	0.1	0.1	0.008
30-Dec-86	20.00	4.0	0.0	0.0	0.0	0.00	0.0	0.1	0.1	0.008
31-Dec-86	21.00	4.5	0.0	0.0	0.0	0.00	0.0	0.1	0.1	0.009
02-Jan-87	23.00	4.5	0.0	0.0	0.0	0.01	0.0	0.1	0.1	0.010
05-Jan-87	26.00	4.5	0.0	0.0	0.0	0.01	0.0	0.2	0.1	0.010
07-Jan-87	28.00	4.5	0.0	0.0	0.0	0.02	0.0	0.2	0.1	0.018
14-Jan-87	35.00	4.5	0.0	0.0	0.0	0.03	0.1	0.2	0.1	0.022
19-Jan-87	40.00	5.5	0.0	0.0	0.0	0.03	0.1	0.2	0.1	0.022
21-Jan-87	42.00	6.5	0.1	0.0	0.0	0.03	0.1	0.2	0.1	0.026
23-Jan-87	44.00	7.0	0.2	0.0	0.0	0.04	0.1	0.2	0.1	0.034
26-Jan-87	47.00	7.0	0.3	0.0	0.0	0.04	0.1	0.2	0.2	0.038
28-Jan-87	49.00	7.3	0.4	0.1	0.0	0.04	0.1	0.2	0.2	0.039
30-Jan-87	51.00	7.3	0.5	0.2	0.0	0.05	0.2	0.2	0.2	0.039
02-Feb-87	54.00	8.0	0.6	0.3	0.0	0.05	0.2	0.2	0.2	0.050
07-Feb-87	59.00	8.0	0.9	0.4	0.0	0.06	0.4	0.2	0.3	0.054
09-Feb-87	61.00	9.0	1.2	0.4	0.0	0.06	0.7	0.2	0.3	0.062
11-Feb-87	63.00	9.0	1.4	0.4	0.0	0.06	0.9	0.3	0.4	0.065
13-Feb-87	65.00	9.5	1.4	0.5	0.0	0.06	1.0	0.3	0.4	0.070
16-Feb-87	68.00	10.0	1.5	0.8	0.0	0.07	1.1	0.4	0.5	0.070
19-Feb-87	71.00	10.5	2.0	1.0	0.0	0.07	1.8	0.4	0.7	0.079
20-Feb-87	72.00	11.0	2.4	1.1	0.0	0.07	2.0	0.5	0.9	0.080
25-Feb-87	77.00	12.0	2.8	1.2	0.0	0.07	2.0	0.5	0.9	0.083
27-Feb-87	79.00	12.4	3.0	1.2	0.1	0.08	3.0	0.6	1.0	0.087
03-Mar-87	83.00	12.4	3.4	1.3	0.4	0.08	3.5	0.8	1.2	0.087
06-Mar-87	86.00	13.0	3.7	1.3	0.6	0.08	4.0	0.8	1.4	0.087
07-Mar-87	87.00	13.0	4.0	1.3	0.8	0.08	4.0	0.9	1.5	0.091
10-Mar-87	90.00	13.5	4.0	1.4	0.8	0.08	4.1	0.9	1.6	0.091
12-Mar-87	92.00	14.0	4.2	1.5	0.9	0.08	4.3	1.0	1.6	0.091
17-Mar-87	97.00	14.0	4.8	1.6	1.0	0.09	4.7	1.1	1.7	0.092
18-Mar-87	98.00	14.0	5.0	1.6	1.1	0.09	4.8	1.2	1.8	0.093
20-Mar-87	100.00	14.0	5.1	1.6	1.1	0.10	5.2	1.2	2.0	0.095
24-Mar-87	104.00	14.0	5.2	1.8	1.2	0.10	5.4	1.3	2.1	0.096
30-Mar-87	110.00	14.0	5.2	1.9	1.3	0.10	5.4	1.4	2.3	0.103
31-Mar-87	111.00	14.0	5.4	2.0	1.4	0.10	5.8	1.5	2.4	0.103
02-Apr-87	113.00	14.0	5.8	2.2	1.5	0.10	6.4	1.6	2.5	0.106
04-Apr-87	115.00	14.0	5.9	2.3	1.6	0.11	6.6	1.7	2.6	0.111
08-Apr-87	119.00	14.0	6.4	2.4	1.8	0.11	EOF	1.7	2.8	0.111
14-Apr-87	125.00	14.0	7.2	2.8	1.9	0.11		1.7	3.0	0.115
21-Apr-87	132.00	14.0	8.0	3.0	2.0	0.12		1.8	3.2	0.117
22-Apr-87	133.00	14.5	8.2	3.2	2.0	0.12		2.0	3.4	0.118
27-Apr-87	138.00	15.0	8.8	3.8	2.0	0.12		2.2	3.6	0.118
29-Apr-87	140.00	15.0	9.4	4.0	2.2	0.12		2.5	3.7	0.119
05-May-87	146.00	16.0	9.5	4.1	2.4	0.12		2.5	3.8	0.119
07-May-87	148.00	18.0	9.8	4.2	2.6	0.12		2.6	3.9	0.120
10-May-87	151.00	19.0	10.0	4.2	2.7	0.12		2.6	4.0	0.120
12-May-87	153.00	21.0	10.0	4.5	2.7	0.12		2.8	4.4	0.120
14-May-87	155.00	23.0	10.0	4.5	2.8	0.12		2.8	4.5	0.121
18-May-87	159.00	24.0	10.0	4.6	3.0	0.12		3.0	4.6	0.123
20-May-87	161.00	25.0	10.0	4.8	3.3	0.13		3.1	4.8	0.126
22-May-87	163.00	25.0	10.4	4.8	3.5	0.13		3.2	5.0	0.128
25-May-87	166.00	26.0	10.4	4.8	3.6	0.13		3.3	5.1	0.130
27-May-87	168.00	27.0	10.4	4.9	3.6	0.14		3.5	5.4	0.131
30-May-87	171.00	28.0	10.9	5.0	3.6	0.14		3.7	5.6	0.131
02-Jun-87	174.00	28.0	10.9	5.4	3.6	0.14		3.8	5.8	0.130

05-Jun-87	177.00	28.0	10.9	5.8	3.7	0.14		3.9	6.0	0.134
08-Jun-87	180.00	28.0	10.9	6.0	3.8	0.14		4.0	6.0	0.135
10-Jun-87	182.00	28.0	11.5	6.0	3.9	0.14		4.0	6.1	0.135
12-Jun-87	184.00	28.0	11.5	6.1	4.0	0.14		4.1	6.2	0.135
15-Jun-87	187.00	28.0	12.0	6.2	4.1	0.14		4.3	6.4	0.137
17-Jun-87	189.00	28.0	12.0	6.5	4.2	0.14		4.4	6.5	0.140
22-Jun-87	194.00	28.0	12.5	6.8	4.7	0.14		4.8	6.6	0.140
26-Jun-87	198.00	28.0	12.5	7.0	4.8	0.14		5.0	6.8	0.142
11-Jul-87	213.00	29.0	14.0	8.4	5.8	0.15		5.6	EOF	0.145
13-Jul-87	215.00	30.5	15.5	9.0	6.[illegible]	0.15		5.7		0.148
22-Jul-87	224.00	32.0	18.0	10.0	7.4	0.16		5.9		0.151
03-Aug-87	236.00	33.0	22.0	11.2	8.2	0.16		6.0		0.155
07-Aug-87	240.00	35.0	23.5	12.2	9.6	0.16		6.1		0.158
11-Aug-87	244.00	38.0	24.0	[illegible]	9.7	0.17		6.3		0.158
12-Aug-87	245.00	39.0	25.0	13.3	9.8	0.17	EOF	EOF	EOF	0.159
18-Aug-87	251.00	40.0	25.5	13.5	10.0	0.17				0.159
26-Aug-87	259.00	44.0	26.0	14.5	11.0	0.17				0.159
07-Sep-87	271.00	44.0	27.5	15.5	11.5	0.17				0.160
14-Sep-87	278.00	45.5	29.0	16.5	12.0	0.18				0.163
23-Sep-87	287.00	45.5	32.0	17.5	12.5	0.18				0.165
01-Oct-87	295.00	45.5	32.5	18.0	13.0	0.18				0.165
12-Oct-87	306.00	45.5	33.0	18.5	13.2	0.18				0.165
16-Oct-87	310.00	45.5	33.5	19.0	13.5	0.18				0.169
21-Oct-87	315.00	45.5	34.5	19.5	13.6	0.18				
29-Oct-87	323.00	45.5	35.5	20.0	14.5	0.18				
03-Nov-87	328.00	45.5	35.5	20.0	EOF	0.19				
12-Nov-87	337.00	45.5	37.5	20.5		0.19				
19-Nov-87	344.00	45.5	38.0	21.0		0.19				
30-Nov-87	355.00	45.5	38.5	22.0		0.19				
07-Dec-87	362.00	45.5	39.0	22.2		0.19				
15-Dec-87	370.00	45.5	40.0	23.0		0.19				
22-Dec-87	377.00	45.5	40.5	EOF		0.19				
05-Jan-88	391.00	45.5	41.0			0.19				
11-Jan-88	397.00	45.5	41.0			0.19				
18-Jan-88	404.00	45.5	41.0			0.19	EOF	EOF		
20-Jan-88	406.00	45.5	41.0			0.19				
26-Jan-88	412.00	45.5	41.0			0.19				
08-Feb-88	425.00	45.5	41.5			0.19				
[illegible]6-Feb-88	433.00	45.5	42.0			0.19				
[illegible]-Feb-88	439.00	45.5	42.5			0.19				
03-Mar-88	449.00	45.5	42.5			0.19				
19-Mar-88	465.00	45.5	42.5			0.20				
03-May-88	510.00	45.5	43.0			0.20				
			EOF	EOF	EOF	EOF	EOF	EOF	EOF	EOF

STATION H1

DATE	DAYS	FACE ADVNC (m)	VRT. STRS SSM 15-11	STRK.STRS SSM 15-	DIP STRS SSM 15-4	VRT.STRS	CLSR. RDNG MC 083	CLCTD CLSR (mm)	STRAIN	DEVIA SIG1-
25-Aug-88	0	0.00	0.00	0.00	0.00		240.00	0.00	0.00	
02-Sep-88	8	0.00	0.00	0.00	0.00		230.00	10.00	0.01	
08-Sep-88	14	3.30	0.00	0.00	0.00		222.00	18.00	0.02	
12-Sep-88	18	8.30	0.00	0.00	0.00		212.00	28.00	0.04	
19-Sep-88	25	9.60	0.05	0.05	0.00		200.00	40.00	0.05	
27-Sep-88	33	13.00	0.17	0.10	0.05		195.00	45.00	0.06	
03-Oct-88	39	14.30	0.37	0.32	0.10		180.00	60.00	0.08	
06-Oct-88	42	15.00	0.59	0.35	0.14		145.00	95.00	0.12	
11-Oct-88	47	16.30	1.00	0.40	0.25		108.00	132.00	0.17	
17-Oct-88	53	16.30	1.40	0.52	0.40		97.00	143.00	0.18	
20-Oct-88	56	16.30	2.00	0.85	0.50		95.00	145.00	0.18	
03-Nov-88	70	16.30	2.90	1.00	0.90		93.00	147.00	0.19	
07-Nov-88	74	16.30	3.20	1.40	1.20		92.00	148.00	0.19	
16-Nov-88	83	16.30	3.70	2.00	1.70		91.00	149.00	0.19	
23-Nov-88	90	16.30	4.40	2.60	2.30		84.00	156.00	0.20	
08-Dec-88	105	16.30	5.00	3.50	3.10		77.00	163.00	0.21	
13-Dec-88	110	16.30	7.20	3.80	3.40		77.00	163.00	0.21	
22-Dec-88	119	16.30	8.00	4.30	3.90		76.00	164.00	0.21	
27-Dec-88	124	16.30	9.00	EOF	4.30		76.00	164.00	0.21	
04-Jan-89	132	16.30	10.00		4.60		75.00	165.00	0.21	
10-Jan-89	138	16.30	11.50		5.00		72.00	168.00	0.21	
18-Jan-89	146	16.30	12.50		5.50		70.00	170.00	0.22	
26-Jan-89	154	16.30	14.00		6.50		68.00	172.00	0.22	
02-Feb-89	161	17.00	15.50		EOF		67.00	173.00	0.22	
09-Feb-89	168	18.00	17.50				67.00	173.00	0.22	
14-Feb-89	173	19.00	19.00				66.00	174.00	0.22	
22-Feb-89	181	20.00	22.50				66.00	174.00	0.22	
23-Feb-89	182	20.00	23.00				65.00	175.00	0.22	
23-Feb-89	182	20.00	23.50				65.00	175.00	0.22	
24-Feb-89	183	20.00	25.00				54.00	176.00	0.22	
27-Feb-89	186	20.80	27.00				64.00	176.00	0.22	
28-Feb-89	187	21.50	28.50				64.00	176.00	0.22	
03-Mar-89	190	22.50	30.00				64.00	176.00	0.22	
10-Mar-89	197	23.80	32.00				64.00	176.00	0.22	
16-Mar-89	203	25.60	33.50				64.00	176.00	0.22	
22-Mar-89	209	27.60	34.50				64.00	176.00	0.22	
30-Mar-89	217	30.00	35.50				64.00	176.00	0.22	
03-Apr-89	221	31.60	36.50				63.00	177.00	0.23	
08-Apr-89	226	32.80	39.50				63.00	177.00	0.23	
12-Apr-89	230	33.30	42.00				63.00	177.00	0.23	
17-Apr-89	235	34.30	44.00				63.00	177.00	0.23	
19-Apr-89	237	36.60	46.00				63.00	177.00	0.23	
24-Apr-89	242	37.40	49.00				63.00	177.00	0.23	
27-Apr-89	245	40.50	51.00				EOF	179.00	0.23	
04-May-89	252	43.20	53.00					180.00	0.23	
11-May-89	259	44.30	56.00					182.00	0.23	
15-May-89	263	45.40	60.00					183.00	0.23	

18-May-89	266	45.40	66.00					184.00	0.23
22-May-89	270	45.40	EOF					184.00	0.23
25-May-89	273	45.40						184.00	0.23
29-May-89	277	46.00						184.00	0.23
01-Jun-89	280	46.00						184.00	0.23
07-Jun-89	286	49.00						184.00	0.23
13-Jun-89	292	51.00						184.00	0.23
16-Jun-89	295	52.90						184.00	0.23
20-Jun-89	299	52.90						184.00	0.23
23-Jun-89	302	53.50						184.00	0.23
26-Jun-89	305	54.50						184.00	0.23
28-Jun-89	307	54.50						184.00	0.23
03-Jul-89	312	56.50						184.00	0.23
07-Jul-89	316	58.00						184.00	0.23
13-Jul-89	322	59.00						184.00	0.23
18-Jul-89	327	60.00	eof	eof	eof	eof	eof	184.00	0.23
	-32380							184.00	0.23
	-32380							184.	0.23
	-32380							184.00	0.23
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	-32380							184.00	0.23
	-32380							184.00	0.23
	-32280							184.00	0.23
	-32380							184.00	0.23
	-32380							184.00	0.23
	-32380							184.00	0
	-32380							184.00	0.23
	-32380							184.00	0.23
	-32380							184.00	0.23
	-32380							184.00	0.23
	-32380							184.00	0.23
	-32380							184.90	0.23
	-32380							184.00	0.23
	-32380							184.00	0.23

WDL94H

STRESS - STRAIN MEASUREMENTS

DATE	DAYS	FACE ADVNC (m)	:	VRT. STRS SSM 15-8	STRK.STRS SSM 15-9	DIP STRS HS 266	VRT.STRS MS 061	CLSR. RDNG MC 035	CLCTD CLSR (mm)
			:	STATION H2					
25-Aug-88	0	0.00	:	0.00	0.00	0.00	0.00	290.00	0.00
02-Sep-88	8	0.00		0.01	0.09	0.03	0.00	278.00	12.00
08-Sep-88	14	3.30	:	0.03	0.00	0.04	0.00	266.00	24.00
12-Sep-88	18	6.30		0.08	0.00	0.05	0.00	259.00	31.00
19-Sep-88	25	9.60	:	0.30	0.06	0.09	0.00	257.00	33.00
27-Sep-88	33	13.00	:	0.60	0.20	0.12	0.00	256.00	34.00
03-Oct-88	39	14.30	:	0.98	0.30	0.15	0.60	255.00	35.00
06-Oct-88	42	15.00	:	1.20	0.35	0.18	0.60	254.00	36.00
11-Oct-88	47	16.30	:	1.70	0.40	0.30	0.80	253.00	37.00
17-Oct-88	53	16.30	:	2.20	0.47	0.51	1.00	252.00	38.00
20-Oct-88	56	16.30	:	2.40	0.51	0.62	1.20	250.00	40.00
03-Nov-88	70	16.30	:	3.00	0.83	0.74	1.60	244.00	46.00
07-Nov-88	74	16.30	:	3.50	1.00	0.85	2.10	236.00	54.00
16-Nov-88	83	16.30	:	4.20	1.20	0.94	2.60	229.00	61.00
23-Nov-88	90	16.30	:	4.60	1.50	1.00	2.80	222.00	68.00
08-Dec-88	105	16.30	:	5.00	1.90	1.60	3.00	216.00	74.00
13-Dec-88	110	16.30	:	EOF	2.00	2.00	3.10	208.00	82.00
22-Dec-88	119	16.30	:		2.30	2.10	3.20	203.00	87.00
27-Dec-88	124	16.30	:		2.50	2.30	3.30	203.00	87.00
04-Jan-89	132	16.30	:		2.70	3.00	3.40	203.00	87.00
10-Jan-89	138	16.30	:		3.00	3.20	3.60	203.00	87.00
18-Jan-89	146	16.30	:		3.40	3.60	3.80	203.00	87.[illegible]
26-Jan-89	154	16.30	:		3.80	4.00	4.00	203.00	87.[illegible]
02-Feb-89	161	17.00	:		4.00	4.50	4.20	198.00	92.00
09-Feb-89	168	18.00	:		EOF	5.00	4.50	197.00	93.00
14-Feb-89	173	19.00	:			5.50	5.00	193.00	97.00
22-Feb-89	181	20.00	:			6.50	6.00	190.00	100.00
23-Feb-89	182	20.00	:			6.50	7.00	189.00	101.00
23-Feb-89	182	20.00	:			6.50	7.50	189.00	101.00
24-Feb-89	183	20.00	:			6.50	9.50	185.00	105.00
27-Feb-89	186	20.80	:			EOF	10.00	184.00	106.00
28-Feb-89	187	21.50	:				12.00	182.00	108.00
03-Mar-89	190	22.50	:				14.00	181.00	109.00
10-Mar-89	197	23.80	:				16.00	180.00	110.00
16-Mar-89	203	25.60	:				19.50	179.00	111.00
22-Mar-89	209	27.60	:				21.00	178.00	112.00
30-Mar-89	217	30.00	:				23.00	178.00	112.00
03-Apr-89	221	31.60	:				26.00	178.00	112.00
08-Apr-89	226	32.80	:				27.50	177.00	113.00
12-Apr-89	230	33.30	:				29.00	177.00	113.00
17-Apr-89	235	34.30	:				31.00	177.00	113.00
19-Apr-89	237	36.60	:				32.00	177.00	113.00
24-Apr-89	242	37.40	:				33.00	177.00	113.00
27-Apr-89	245	40.50	:				35.00	EOF	115.00
04-May-89	252	43.20	:				36.00		117.00
11-May-89	259	44.30	:				37.00		117.00
15-May-89	263	45.40	:				38.00		121.00

18-May-89	266	45.40 :				38.00	121.00
22-May-89	270	45.40 :				39.00	121.00
25-May-89	273	45.40 :				40.00	121.00
29-May-89	277	46.00 :				41.00	121.00
01-Jun-89	280	46.00 :				42.00	121.00
07-Jun-89	286	49.00 :				43.00	121.00
13-Jun-89	292	51.00 :				44.00	121.00
16-Jun-89	295	52.90 :				46.00	121.00
20-Jun-89	299	52.90 :				48.00	121.00
23-Jun-89	302	53.50 :				50.00	121.00
26-Jun-89	305	54.50 :				52.00	121.00
28-Jun-89	307	54.50 :					121.00
03-Jul-89	312	56.50 :					121.00
07-Jul-89	316	58.00 :					121.00
13-Jul-89	322	59.00 :					121.00
18-Jul-89	327	60.00 :	eof	eof	eof	eof	121.00

WDL94H

STATION H3

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 203	STRK.STRS SSM 15-12	DIP STRS HS 260	VRT.STRS MS 066	CLSR. RDNG MC 032	CLCTD CLSR (mm)	STRAIN	CLSR N
25-Aug-88	0	0.00	0.00	0.00	0.00	0.00	243.00	0.00	0.00	
02-Sep-88	8	0.00	0.00	0.00	0.00	0.00	231.00	12.00	0.01	
08-Sep-88	14	3.30	0.02	0.00	0.00	0.00	225.00	18.00	0.02	
12-Sep-88	18	6.30	0.00	0.00	0.00	0.00	215.00	28.00	0.03	
19-Sep-88	25	9.60	0.00	0.05	0.05	0.00	208.00	35.00	0.04	
27-Sep-88	33	13.00	0.00	0.06	0.16	0.00	202.00	41.00	0.05	
03-Oct-88	39	14.30	0.00	0.07	0.24	0.40	194.00	49.00	0.06	
06-Oct-88	42	15.00	0.00	0.09	0.48	0.60	186.00	57.00	0.06	
11-Oct-88	47	16.30	0.00	0.12	0.70	0.80	177.00	66.00	0.07	
17-Oct-88	53	16.30	0.00	0.13	0.80	1.00	170.00	73.00	0.08	
20-Oct-88	56	16.30	0.10	0.15	0.85	1.14	168.00	75.00	0.08	
03-Nov-88	70	16.30	0.21	0.21	0.95	1.60	167.00	76.00	0.09	
07-Nov-88	74	16.30	0.38	0.27	1.20	1.80	167.00	76.00	0.09	
16-Nov-88	83	16.30	0.45	0.30	1.50	2.00	166.00	77.00	0.09	
23-Nov-88	90	16.30	0.60	0.40	1.90	3.20	165.00	78.00	0.09	
08-Dec-88	105	16.30	0.79	0.60	2.20	4.00	162.00	81.00	0.09	
13-Dec-88	110	16.30	0.95	0.75	2.40	4.40	160.00	83.00	0.09	
22-Dec-88	119	16.30	1.10	0.90	2.70	4.80	158.00	85.00	0.10	
27-Dec-88	124	16.30	2.40	1.00	3.00	5.40	154.00	89.00	0.10	
04-Jan-89	132	16.30	EOF	1.20	3.10	5.60	153.00	90.00	0.10	
10-Jan-89	138	16.30		1.40	3.30	6.50	152.00	91.00	0.10	
18-Jan-89	146	16.30		1.90	3.60	8.00	146.00	97.00	0.11	
26-Jan-89	154	16.30		2.10	4.30	10.00	140.00	103.00	0.12	
02-Feb-89	161	17.00		2.40	4.50	12.00	139.00	104.00	0.12	
09-Feb-89	168	18.00		2.70	5.00	14.00	138.00	105.00	0.12	
14-Feb-89	173	19.00		3.10	5.50	16.00	135.00	108.00	0.12	
22-Feb-89	181	20.00		3.80	5.50	17.50	134.00	109.00	0.12	
23-Feb-89	182	20.00		4.00	6.00	21.00	130.00	113.00	0.13	
23-Feb-89	182	20.00		4.10	6.50	21.00	130.00	113.00	0.13	
24-Feb-89	183	20.00		4.50	6.50	22.00	130.00	113.00	0.13	
27-Feb-89	186	20.80		5.00	6.80	22.50	130.00	113.00	0.13	
28-Feb-89	187	21.50		6.00	7.00	23.00	129.00	114.00	0.13	
03-Mar-89	190	22.50		6.50	7.20	24.00	128.00	115.00	0.13	
10-Mar-89	197	23.80		7.00	7.50	24.50	127.00	116.00	0.13	
16-Mar-89	203	25.60		7.50	8.00	25.00	126.00	117.00	0.13	
22-Mar-89	209	27.60		8.00	8.50	25.50	125.00	118.00	0.13	
30-Mar-89	217	30.00		9.00	9.00	28.00	124.00	119.00	0.13	
03-Apr-89	221	31.60		9.50	10.00	30.00	122.00	121.00	0.14	
08-Apr-89	226	32.80		10.00	11.00	34.00	121.00	122.00	0.14	
12-Apr-89	230	33.30		11.00	12.00	36.00	120.00	123.00	0.14	
17-Apr-89	235	34.30		11.50	12.50	36.50	119.00	124.00	0.14	
19-Apr-89	237	36.60		12.00	13.00	37.00	119.00	124.00	0.14	
24-Apr-89	242	37.40		12.50	13.50	38.00	119.00	124.00	0.14	
27-Apr-89	245	40.50		13.00	14.00	38.00	118.00	125.00	0.14	
04-May-89	252	43.20		14.00	15.00	39.00	118.00	125.00	0.14	
11-May-89	259	44.30		15.00	16.00	39.00	117.00	126.00	0.14	
15-May-89	263	45.40		16.00	17.00	39.00	116.00	127.00	0.14	

18-May-89	266	45.40		17.00	18.00	39.00	116.00	127.00	0.14
22-May-89	270	45.40		17.50	18.30	40.00	114.00	129.00	0.14
25-May-89	273	45.40		18.00	18.50	40.00	114.00	129.00	0.14
29-May-89	277	46.00		18.50	19.00	41.00	114.00	129.00	0.14
01-Jun-89	280	46.00		19.00	19.50	42.00	114.00	129.00	0.14
07-Jun-89	286	49.00		20.00	21.00	43.00	EOF	243.00	0.27
13-Jun-89	292	51.00		20.50	22.00	44.00		243.00	0.27
16-Jun-89	295	52.90		20.50	22.50	45.00		243.00	0.27
20-Jun-89	299	52.90		21.00	23.00	46.00		243.00	0.27
23-Jun-89	302	53.50		21.50	23.50	47.00		243.00	0.27
26-Jun-89	305	54.50		22.50	24.00	49.00		243.00	0.27
28-Jun-89	307	54.50		23.00	24.00	51.00		243.00	0.27
03-Jul-89	312	56.50		23.50	24.50	52.00		243.00	0.27
07-Jul-89	316	58.00		24.50	26.00	Pump ooo		243.00	0.27
13-Jul-89	322	59.00		25.50	26.50			243.00	0.27
18-Jul-89	327	60.00	eof	26.00	27.00		eof	243.00	0.27

WDL94H

STATION H4

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 196	STRK.STRS HS 195	DIP STRS HS 205	VRT.STRS MS 034	CLSR. RDNG CM 026	CLCTD CLSR (mm)	STRAIN	CLSR N
25-Aug-88	0	0.00	0.00	0.00	0.00	0.00	176.00	0.00	0.00	
02-Sep-88	8	0.00	0.03	0.00	0.00	0.00	164.00	12.00	0.01	
08-Sep-88	14	3.30	0.05	0.00	0.00	0.00	155.00	21.00	0.02	
12-Sep-88	18	6.30	0.09	0.02	0.00	0.00	140.00	36.00	0.04	
19-Sep-88	25	9.60	0.18	0.06	0.00	0.00	127.00	49.00	0.05	
27-Sep-88	33	13.00	0.39	0.09	0.00	0.40	119.00	57.00	0.06	
03-Oct-88	39	14.30	0.51	0.11	0.00	0.60	117.00	59.00	0.06	
06-Oct-88	42	15.00	0.70	0.16	0.00	0.80	110.00	66.00	0.07	
11-Oct-88	47	16.30	1.00	0.22	0.00	0.80	182.00	75.00	0.08	
17-Oct-88	53	16.30	EOF	0.25	0.00	0.90	180.00	77.00	0.08	
20-Oct-88	56	16.30		0.29	0.00	1.00	180.00	77.00	0.08	
03-Nov-88	70	16.30		0.32	0.00	1.40	179.00	78.00	0.08	
07-Nov-88	74	16.30		0.39	0.00	1.60	179.00	78.00	0.08	
16-Nov-88	83	16.30		0.45	0.00	2.00	178.00	79.00	0.08	
23-Nov-88	90	16.30		0.57	EOF	2.10	175.00	82.00	0.09	
08-Dec-88	105	16.30		0.77		2.40	174.00	83.00	0.09	
13-Dec-88	110	16.30		0.87		2.80	174.00	83.00	0.09	
22-Dec-88	119	16.30		1.00		3.00	174.00	83.00	0.09	
27-Dec-88	124	16.30		1.10		3.20	174.00	83.00	0.09	
04-Jan-89	132	16.30		1.20		3.40	173.00	84.00	0.09	
10-Jan-89	138	16.30		1.30		EOF	173.00	84.00	0.09	
18-Jan-89	146	16.30		1.50			172.00	85.00	0.09	
26-Jan-89	154	16.30		1.80			171.00	86.00	0.09	
02-Feb-89	161	17.00		2.00			171.00	86.00	0.09	
09-Feb-89	168	18.00		2.20			170.00	87.00	0.09	
14-Feb-89	173	19.00		2.40			170.00	87.00	0.09	
22-Feb-89	181	20.00		2.70			165.00	92.00	0.10	
23-Feb-89	182	20.00		3.20			165.00	92.00	0.10	
23-Feb-89	182	20.00		3.40			163.00	94.00	0.10	
24-Feb-89	183	20.00		3.40			163.00	94.00	0.10	
27-Feb-89	186	20.80		3.50			163.00	94.00	0.10	
28-Feb-89	187	21.50		3.80			163.00	94.00	0.10	
03-Mar-89	190	22.50		4.00			163.00	94.00	0.10	
10-Mar-89	197	23.80		4.20			163.00	94.00	0.10	
16-Mar-89	203	25.60		4.50			163.00	94.00	0.10	
22-Mar-89	209	27.60		4.80			163.00	94.00	0.10	
30-Mar-89	217	30.00		5.00			163.00	94.00	0.10	
03-Apr-89	221	31.60		5.20			163.00	94.00	0.10	
08-Apr-89	226	32.80		5.50			163.00	94.00	0.10	
12-Apr-89	230	33.30		6.00			163.00	94.00	0.10	
17-Apr-89	235	34.30		6.50			163.00	94.00	0.10	
19-Apr-89	237	36.60		7.00			163.00	94.00	0.10	
24-Apr-89	242	37.40		7.20			163.00	94.00	0.10	
27-Apr-89	245	40.50		7.50			163.00	94.00	0.10	
04-May-89	252	43.20		EOF			EOF	257.00	0.27	

WDL94H

STATION H4

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 196	STRK.STRS HS 195	DIP STRS HS 205	VRT.STRS MS 034	CLSR. RDNG CM 026	CLCTD CLSR (mm)	STRAIN	CLSR N
25-Aug-88	0	0.00	0.00	0.00	0.00	0.00	176.00	0.00	0.00	
02-Sep-88	8	0.00	0.03	0.00	0.00	0.00	164.00	12.00	0.01	
08-Sep-88	14	3.30	0.05	0.00	0.00	0.00	155.00	21.00	0.02	

12-Sep-88	18	6.30	0.09	0.02	0.00	0.00	140.00	36.00	0.04
19-Sep-88	25	9.60	0.18	0.06	0.00	0.00	127.00	49.00	0.05
27-Sep-88	33	13.00	0.39	0.09	0.00	0.40	119.00	57.00	0.06
03-Oct-88	39	14.30	0.51	0.11	0.00	0.60	117.00	59.00	0.06
06-Oct-88	42	15.00	0.70	0.16	0.00	0.80	110.00	66.00	0.07
11-Oct-88	47	16.30	1.00	0.22	0.00	0.80	182.00	75.00	0.08
17-Oct-88	53	16.30	EOF	0.25	0.00	0.90	180.00	77.00	0.08
20-Oct-88	56	16.30		0.29	0.00	1.00	180.00	77.00	0.08
03-Nov-88	70	16.30		0.32	0.00	1.40	179.00	78.00	0.08
07-Nov-88	74	16.30		0.39	0.00	1.60	179.00	[illegible]	0.08
16-Nov-88	83	16.30		0.45	0.00	2.00	178.00	79.00	0.08
23-Nov-88	90	16.30		0.57	EOF	2.10	175.00	82.00	0.09
08-Dec-88	105	16.30		0.77		2.40	174.00	83.00	0.09
13-Dec-88	110	16.30		0.87		2.80	174.00	83.00	0.09
22-Dec-88	119	16.30		1.00		3.00	174.00	83.00	0.09
27-Dec-88	124	16.30		1.10		3.20	174.00	83.00	0.09
04-Jan-89	132	16.30		1.20		3.40	173.00	84.00	0.09
10-Jan-89	138	16.30		1.30		EOF	173.00	84.00	0.09
18-Jan-89	146	16.30		1.50			172.00	85.00	0.09
26-Jan-89	154	16.30		1.80			171.00	86.00	0.09
02-Feb-89	161	17.00		2.00			171.00	86.00	0.09
09-Feb-89	168	18.00		2.20			170.00	87.00	0.09
14-Feb-89	173	19.00		2.40			170.00	87.00	0.09
[illegible]	181	20.00		2.70			165.00	92.00	0.10
[illegible]	[illegible]	20.00		3.20			165.00	92.00	0.10
23-Feb-89	182	20.00		3.40			163.00	94.00	0.10
24-Feb-89	183	20.00		3.40			163.00	94.00	0.10
27-Feb-89	186	20.80		3.50			163.00	94.00	0.10
28-Feb-89	187	21.50		3.80			163.00	94.00	0.10
03-Mar-89	190	22.50		4.00			163.00	94.00	0.10
10-Mar-89	197	23.80		4.20			163.00	94.00	0.10
16-Mar-89	203	25.60		4.50			163.00	94.00	0.10
22-Mar-89	209	27.60		4.80			163.00	94.00	0.10
30-Mar-89	217	30.00		5.00			163.00	94.00	0.10
03-Apr-89	221	31.60		5.20			163.00	94.00	0.10
08-Apr-89	226	32.80		5.50			163.00	94.00	0.10
12-Apr-89	230	33.30		6.00			163.00	94.00	0.10
17-Apr-89	235	34.30		6.50			163.00	94.00	0.10
19-Apr-89	237	36.60		7.00			163.00	94.00	0.10
24-Apr-89	242	[illegible]		7.20			163.00	94.00	0.10
27-Apr-89	245	40.50		7.50			163.00	94.00	0.10
04-May-89	252	43.20		EOF			EOF	257.00	0.27

STATION "G" PANEL 94E2

	No OF DAYS	Vert MPa	STRK MPa	DIP MPa	VERT-STR	VERT-DIP	STRAIN	Dip\Vert	Strike\Vert
04-Feb-88	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14-Feb-88	10.000	0.030	0.000	0.000	0.030	0.030	0.037	0.000	0.000
18-Feb-88	14.000	0.040	0.000	0.030	0.040	0.010	0.052	0.750	0.000
25-Feb-88	21.000	0.125	0.030	0.060	0.095	0.065	0.057	0.480	0.240
29-Feb-88	25.000	0.210	0.045	0.085	0.165	0.125	0.060	0.405	0.214
03-Mar-88	28.000	0.245	0.050	0.090	0.195	0.155	0.062	0.367	0.204
11-Mar-88	36.000	0.690	0.120	0.150	0.570	0.540	0.064	0.217	0.174
1--Mar-88	39.000	0.940	0.150	0.210	0.790	0.730	0.064	0.223	0.160
17-Mar-88	42.000	1.200	0.170	0.250	1.030	0.950	0.064	0.208	0.142
21-Mar-88	46.000	1.300	0.190	0.300	1.110	1.000	0.066	0.231	0.146
29-Mar-88	54.000	2.000	0.260	0.700	1.740	1.300	0.066	0.350	0.130
06-Apr-88	62.000	2.800	0.400	0.900	2.400	1.900	0.067	0.321	0.143
11-Apr-88	67.000	3.200	0.520	1.200	2.680	2.000	0.069	0.375	0.163
15-Apr-88	71.000	3.800	0.690	1.400	3.110	2.400	0.073	0.368	0.182
20-Apr-88	76.000	5.000	0.890	1.600	4.110	3.400	0.077	0.320	0.178
25-Apr-88	81.000	6.000	1.200	2.200	4.800	3.800	0.079	0.367	0.200
29-Apr-88	85.000	7.000	1.600	2.600	5.400	4.400	0.082	0.371	0.229
05-May-88	91.000	8.000	1.800	3.000	6.200	5.000	0.089	0.375	0.225
10-May-88	96.000	9.000	2.000	3.300	7.000	5.700	0.092	0.367	0.222
13-May-88	99.000	10.000	2.100	3.500	7.900	6.500	0.097	0.350	0.210
17-May-88	103.000	11.000	2.300	3.600	8.700	7.400	0.098	0.327	0.209
21-May-88	107.000	12.000	2.500	4.000	9.500	8.000	0.101	0.333	0.208
25-May-88	111.000	13.000	3.000	4.500	10.000	8.500	0.103	0.346	0.231
01-Jun-88	118.000	14.000	3.500	5.000	10.500	9.000	0.109	0.357	0.250
06-Jun-88	123.000	15.500	3.700	6.000	11.800	9.500	0.115	0.387	0.239
10-Jun-88	127.000	16.500	3.900	6.500	12.600	10.000	0.120	0.394	0.236
14-Jun-88	131.000	17.500	4.100	7.000	13.400	10.500	0.120	0.400	0.234
20-Jun-88	137.000	18.500	4.500	7.500	14.000	11.000	0.124	0.405	0.243
24-Jun-88	141.000	19.500	4.800	7.800	14.700	11.700	0.125	0.400	0.246
30-Jun-88	147.000	20.500	5.000	8.000	15.500	12.500	0.129	0.390	0.244
06-Jul-88	153.000	22.000	6.000	8.500	16.000	13.500	0.132	0.386	0.273
12-Jul-88	159.000	23.000	7.000	9.000	16.000	14.000	0.135	0.391	0.304
15-Jul-88	162.000	25.000	7.500	9.500	17.500	15.5.J	0.136	0.380	0.300
20-Jul-89	167.000	26.500	7.800	10.800	18.700	15.700	0.139	0.408	0.294
			8.000	11.500	-8.000	-11.500	0.150	ERR	ERR
			8.500	12.000	-8.500	-12.000	0.151	ERR	ERR
			9.000	12.800	-9.000	-12.800	0.152	ERR	ERR
			10.000	13.500	-10.000	-13.500	0.154	ERR	ERR
			10.500	14.000	-10.500	-14.000	0.155	ERR	ERR
			11.000	15.000	-11.000	-15.000	0.158	ERR	ERR
			12.500	17.000	-12.500	-17.000	0.162	ERR	ERR
			13.000	17.500	-13.000	-17.500	0.167	ERR	ERR
			13.200	18.000	-13.200	-18.000	0.169	ERR	ERR
			14.000	18.700	-14.000	-18.700	0.172	ERR	ERR
			15.000	19.500	-15.000	-19.500	0.173	ERR	ERR
				20.000	0.000	-20.000	0.174	ERR	ERR
				21.000	0.000	-21.000	0.174	ERR	ERR

WD18J

STATION J1

DATE	DAYS	FACE ADV (m)	VERT.STRES HMS (MPa)	STRIKE STRES HSM (MPa)	DIP STRES HSM (MPa)	VERT. STRES MRTZ (MPa)	CLOS METER OLD (mm)	ACTUAL CLOS (mm)	STRAIN SW (970mm)	CLOS NEW
31-Aug-88	0.00	0.00	0.00	0.00	0.00	0.00	182.00	0.00	0.00	
05-Sep-88	5.00	1.00	0.03	0.00	0.00	0.00	168.00	14.00	0.01	
19-Sep-88	19.00	2.00	0.07	0.00	0.00	0.10	154.00	28.00	0.03	
25-Oct-88	55.00	5.50	0.10	0.05	0.02	0.50	108.00	74.00	0.08	
16-Nov-88	77.00	7.80	0.12	0.06	0.05	0.70	70.00	112.00	0.12	
08-Dec-88	99.00	8.80	0.15	0.07	0.06	0.80	61.00	121.00	0.12	
15-Dec-88	106.00	9.60	0.20	0.08	0.07		52.00	130.00	0.13	
23-Dec-88	114.00	10.00	0.26	0.10	0.08		48.00	134.00	0.14	
28-Dec-88	119.00	10.50	0.54	0.15	0.14		30.00	152.00	0.16	
04-Jan-89	126.00	10.50	0.63	0.16	0.17		26.00	156.00	0.16	
10-Jan-89	132.00	13.00	0.80	0.18	0.18		23.00	159.00	0.16	
18-Jan-89	140.00	14.00	1.00	0.23	0.19		178.00	162.00	0.17	
26-Jan-89	148.00	15.50	1.40	0.26	0.20		176.00	164.00	0.17	
31-Jan-89	153.00	15.50	1.70	0.28	0.21		174.00	166.00	0.17	
03-Feb-89	156.00	16.00	1.80	0.30	0.22		171.00	169.00	0.17	
10-Feb-89	163.00	18.00	2.00	0.32	0.23		169.00	171.00	0.18	
22-Feb-89	175.00	20.00	2.30	0.41	0.28		167.00	173.00	0.18	
27-Feb-89	180.00	20.00	2.40	0.46	0.32		164.00	176.00	0.18	
01-Mar-89	182.00	21.00	2.50	0.53	0.37		161.00	179.00	0.18	
06-Mar-89	187.00	21.00	2.60	0.68	0.40		159.00	181.00	0.19	
10-Mar-89	191.00	22.50	2.70	0.75	0.46		157.00	183.00	0.19	
16-Mar-89	197.00	24.50	2.90	0.91	0.52		154.00	186.00	0.19	
28-Mar-89	209.00	25.60	3.00	1.00	0.69		154.00	186.00	0.19	
04-Apr-89	216.00	28.00	3.30	1.10	0.78		154.00	186.00	0.19	
08-Apr-89	220.00	28.00	3.50	1.20	0.90		154.00	186.00	0.19	
11-Apr-89	223.00	28.50	3.90	1.30	1.00		154.00	186.00	0.19	
18-Apr-89	230.00	29.00	4.00	1.35	1.10		152.00	188.00	0.19	
24-Apr-89	236.00	30.00	4.30	1.40	1.20		151.00	189.00	0.19	
27-Apr-89	239.00	31.00	4.30	1.40	1.20		150.00	190.00	0.20	
02-May-89	244.00	31.70	4.40	1.50	1.20		148.00	192.00	0.20	
05-May-89	247.00	31.70	4.50	1.50	1.20		146.00	194.00	0.20	
09-May-89	251.00	31.70	4.60	1.50	1.30		145.00	195.00	0.20	
15-May-89	257.00	31.70	4.70	1.60	1.30		145.00	195.00	0.20	
19-May-89	261.00	31.70	5.00	1.80	1.40		144.00	196.00	0.20	
24-May-89	266.00	31.70	5.20	1.90	1.40		144.00	196.00	0.20	
30-May-89	272.00	31.70	5.20	2.00	1.60		144.00	196.00	0.20	
07-Jun-89	280.00	31.70	5.70	2.20	1.70		141.00	199.00	0.21	
12-Jun-89	285.00	31.70	5.80	2.40	1.80		140.00	200.00	0.21	
19-Jun-89	292.00	31.70	6.10	2.50	2.00		140.00	200.00	0.21	
26-Jun-89	299.00	31.70	6.20	2.60	2.20		139.00	201.00	0.21	
03-Jul-89	306.00	31.70	6.30	2.70	2.50		138.00	202.00	0.21	
10-Jul-89	313.00	31.70	6.50	3.00	2.60		135.00	205.00	0.21	
18-Jul-89	321.00	31.70	6.50	3.40	2.60		133.00	207.00	0.21	
03-Aug-89	337.00		6.50	3.40	2.80		132.00	208.00	0.21	
21-Aug-89	355.00		6.50	3.40	2.80		132.00	208.00	0.21	
05-Sep-89	370.00		6.50	3.50	2.90		132.00	208.00	0.21	
18-Sep-89	383.00		6.50	3.50	3.00		131.00	209.00	0.22	
04-Oct-89	399.00		6.50	3.50	3.00		131.00	209.00	0.22	
18-Oct-89	413.00		6.50	3.50	3.00		131.00	209.00	0.22	

03-Nov-89	429.00		6.50	3.50	3.00	131.00	209.00	0.22
16-Nov-89	442.00	31.70	6.50	3.50	3.00	131.00	209.00	0.22

STATION J2

DATE	DAYS	FACE ADV (m)	VERT. STRES HSM (MPa)	STRIKE STRES HSM (MPa)	DIP STRESS HSM (MPa)	VERT STRES MARITZ (MPa)	CLOS METER mc 081	ACTUAL CLOS (mm)	STRAIN SW (980mm)	CLOS NEW
3 Aug-88	0.00	0.00	0.00	0.00	0.00	0.00	189.00	0.00	0.00	
05-Sep-88	5.00	1.00	0.00	0.00	0.00		176.00	13.00	0.01	
19-Sep-88	19.00	2.00	0.05	0.00	0.00		168.00	21.00	0.02	
25-Oct-88	55.00	5.50	0.10	0.07	0.00		165.00	24.00	[illegible]	
16-Nov-88	77.00	7.80	0.14	0.10	0.07		171.00	18.00	0.02	
08-Dec-88	99.00	8.80	0.17	0.12	0.10		171.00	18.00	0.02	
15-Dec-88	106.00	9.60	0.18	0.13	0.12		171.00	18.00	0.02	
23-Dec-88	114.00	10.00	0.24	0.15	0.16		171.00	18.00	0.02	
28-Dec-88	119.00	10.50	0.42	0.22	0.27		171.00	18.00	0.02	
04-Jan-89	126.00	10.50	0.33	0.24	0.30		171.00	18.00	0.02	
10-Jan-89	132.00	13.00	0.67	0.29	0.44		171.00	18.00	0.02	
18-Jan-89	140.00	14.00	0.90	0.31	0.66		171.00	18.00	0.02	
26-Jan-89	148.00	15.50	1.00	0.44	0.90		170.00	19.00	0.02	
31-Jan-89	153.00	15.50	1.20	0.47	1.10		170.00	19.00	0.02	
03-Feb-89	156.00	16.00	1.40	0.49	1.30		170.00	19.00	0.02	
10-Feb-89	163.00	18.00	1.50	0.50	1.40		170.00	19.00	0.02	
22-Feb-89	175.00	20.00	1.70	0.65	1.70		170.00	19.00	0.02	
27-Feb-89	180.00	20.00	1.80	0.72	1.80		170.00	19.00	0.02	
01-Mar-89	182.00	21.00	1.90	0.85	1.90		169.00	20.00	0.02	
06-Mar-89	187.00	21.00	2.00	0.96	2.00		168.00	21.00	0.02	
10-Mar-89	191.00	22.50	2.05	1.10	2.20		168.00	21.00	0.02	
16-Mar-89	197.00	24.50	2.10	1.20	2.30		168.00	21.00	0.02	
28-Mar-89	209.00	25.60	2.30	1.30	2.70		167.00	22.00	0.02	
04-Apr-89	216.00	28.00	2.60	1.40	2.90		167.00	22.00	0.02	
08-Apr-89	220.00	28.00	2.90	1.50	3.00		167.00	22.00	0.02	
11-Apr-89	223.00	28.50	3.10	1.60	3.20		167.00	22.00	0.02	
18-Apr-89	230.00	29.00	3.40	1.70	3.30		167.00	22.00	0.02	
24-Apr-89	236.00	30.00	3.50	1.90	3.60		167.00	22.00	0.02	
27-Apr-89	239.00	31.00	3.60	1.90	3.60		167.00	22.00	0.02	
02-May-89	244.00	31.70	3.70	1.90	3.70		167.00	22.00	0.02	
05-May-89	247.00	31.70	3.70	2.00	3.80		167.00	22.00	0.02	
09-May-89	251.00	31.70	3.90	2.00	3.90		167.00	22.00	0.02	
15-May-89	257.00	31.70	4.00	2.00	4.00		165.00	24.00	0.02	
19-May-89	261.00	31.70	4.10	2.10	4.10		163.00	26.00	0.03	
24-May-89	266.00	31.70	4.30	2.20	4.20		160.00	29.00	0.03	
30-May-89	272.00	31.70	4.40	2.30	4.30		157.00	32.00	0.03	
07-Jun-89	280.00	31.70	4.70	2.50	4.30		157.00	32.00	0.03	
12-Jun-89	285.00	31.70	4.80	2.60	4.50		157.00	32.00	0.03	
19-Jun-89	292.00	31.70	5.00	2.80	4.60		157.00	32.00	0.03	
26-Jun-89	299.00	31.70	5.10	2.90	4.70		157.00	32.00	0.03	
03-Jul-89	306.00	31.70	5.30	2.90	4.80		157.00	32.00	0.03	
10-Jul-89	313.00	31.70	5.40	3.00	eof		eof	189.00	0.19	
18-Jul-89	321.00	31.70	5.50	3.50				189.00	0.19	
03-Aug-89	337.00		EOF	3.60				189.00	0.19	
21-Aug-89	355.00			3.70				189.00	0.19	
05-Sep-89	370.00			3.70				189.00	0.19	
18-Sep-89	383.00			3.80				189.00	0.19	
04-Oct-89	399.00			3.90				189.00	0.19	
18-Oct-89	413.00			4.00				189.00	0.19	
03-Nov-89	429.00			4.00				189.00	0.19	
16-Nov-89	442.00	31.70		4.00				189.00	0.19	

STATION J3

DATE	DAYS	FACE ADV (m)	VERT STRES HSM (MPa)	STRIKE STRES HSM (MPA)	DIP STRESS HSM (MPa)	VERT STRES MARITZ (MPa)	CLOS METER OLD (mm)	ACTUAL CLOS (mm)	STRAIN SW (1170mm)	CLOS NEW
31-Aug-88	0.00	0.00	0.00	0.00	0.00	0.00	145.00	0.00	0.00	
05-Sep-88	5.00	1.00	0.05	0.00	0.00	0.10	133.00	12.00	0.01	
19-Sep-88	19.00	2.00	0.07	0.00	0.05	0.40	108.00	37.00	0.03	
25-Oct-88	55.00	5.50	0.13	0.00	0.10	0.60	84.00	61.00	0.05	
16-Nov-88	77.00	7.80	0.28	0.00	0.20	0.70	73.00	72.00	0.06	
08-Dec-88	99.00	8.80	0.69	0.03	0.50	1.80	68.00	77.00	0.07	
15-Dec-88	106.00	9.60	0.95	0.06	0.69	2.20	60.00	85.00	0.07	
23-Dec-88	114.00	10.00	1.20	0.09	0.80	2.80	58.00	87.00	0.07	
2[illegible]-Dec-88	119.00	10.50	2.00	0.25	1.20	3.00	57.00	88.00	0.08	
04-Jan-89	126.00	10.50	2.30	0.30	1.40	3.20	54.00	91.00	0.08	
10-Jan-89	132.00	13.00	2.60	0.55	1.50	[illegible].20	46.00	99.00	0.08	
18-Jan-89	140.00	14.00	3.10	0.70	1.90	3.30	116.00	111.00	0.09	
26-Jan-89	148.00	15.50	3.30	1.00	2.10	3.40	113.00	114.00	0.10	
31-Jan-89	153.00	15.50	3.70	1.20	2.20	3.50	110.00	117.00	0.10	
03-Feb-89	156.00	16.00	3.80	1.50	2.30	3.50	106.00	121.00	0.10	
10-Feb-89	163.00	18.00	4.00	1.70	2.40	4.00	106.00	121.00	0.10	
22-Feb-89	175.00	20.00	4.40	1.90	2.60	4.50	106.00	121.00	0.10	
27-Feb-89	180.00	20.00	4.60	1.95	2.80	4.80	105.00	122.00	0.10	
01-Mar-89	182.00	21.00	4.80	2.00	3.00	5.00	103.00	124.00	0.11	
06-Mar-89	187.00	21.00	5.40	2.10	3.10	5.50	100.00	127.00	0.11	
10-Mar-89	191.00	22.50	6.00	2.20	3.20	6.00	96.00	131.00	0.11	
16-Mar-89	197.00	24.50	6.50	2.35	3.35	7.00	92.00	135.00	0.12	
28-Mar-89	209.00	25.60	eof	2.40	3.50	7.50	92.00	135.00	0.12	
04-Apr-89	216.00	28.00		2.50	3.70	8.00	92.00	135.00	0.12	
08-Apr-89	220.00	28.00		2.80	3.90	8.50	92.00	135.00	0.12	
11-Apr-89	223.00	28.50		3.00	4.00	9.00	92.00	135.00	0.12	
18-Apr-89	230.00	29.00		3.40	4.10	9.00	92.00	135.00	0.12	
24-Apr-89	236.00	30.00		3.50	4.20	9.00	92.00	135.00	0.12	
27-Apr-89	239.00	31.00		eof	4.50	eof	eof	227.00	0.19	
02-May-89	244.00	31.70			4.80			227.00	0.19	
05-May-89	247.00	31.70			5.00			227.00	0.19	
09-May-89	251.00	31.70			5.10			227.00	0.19	
15-May-89	257.00	31.70			5.20			227.00	0.19	
19-May-89	261.00	31.70			5.40			227.00	0.19	
24-May-89	266.00	31.70			5.60			227.00	0.19	
30-May-89	272.00	31.70			5.80			227.00	0.19	
07-Jun-89	280.00	31.70			6.00			227.00	0.19	
12-Jun-89	285.00	31.70			6.00			227.00	0.19	
19-Jun-89	292.00	31.70			6.00			227.00	0.19	
26-Jun-89	299.00	31.70			6.00			227.00	0.19	
03-Jul-89	306.00	31.70			6.00			227.00	0.19	
10-Jul-89	313.00	31.70			6.30			227.00	0.19	
16-Jul-89	321.00	31.70	EOF	eof	6.50	eof	eof	227.00	0.19	
03-Aug-89	337.00				7.00			227.00	0.19	
21-Aug-89	355.00				8.00			227.00	0.19	
05-Sep-89	370.00				8.00			227.00	0.19	
18-Sep-89	383.00				8.00			227.00	0.19	
04-Oct-89	399.00				8.00			227.00	0.19	
18-Oct-89	413.00				8.00			227.00	0.19	
03-Nov-89	429.00				8.00			227.00	0.19	
16-Nov-89	442.00	31.70			8.50			227.00	0.19	

WDL87K

STATION K1

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 146	STRK.STRS HS 284	DIP STRS HS 111	VRT.STRS MS 048	CLSR. RDNG MC 048	CLCTD CLSR (mm)	STRAIN	CLSR. R SCM 4
17-Feb-89										
24-Feb-89										
28-Feb-89										
07-Mar-89	0	0.00	0.00	0.00	0.00	0.00	144.00	0.00	0.00	19
13-Mar-89	6	2.30	0.06	0.04	0.03	0.00	151.00	7.00	0.01	18
16-Mar-89	9	4.40	0.13	0.08	0.05	0.00	156.00	12.00	0.02	17
21-Mar-89	14	5.50	0.40	0.11	0.14	0.24	160.00	16.00	0.02	17
30-Mar-89	23	8.40	0.65	0.18	0.26	0.40	163.00	19.00	0.02	17
05-Apr-89	29	9.50	0.80	0.25	0.37	0.80	164.00	20.00	0.03	17
10-Apr-89	34	10.80	0.92	0.30	0.45	0.90	168.00	24.00	0.03	16
12-Apr-89	36	10.80	1.00	0.37	0.58	1.00	170.00	26.00	0.03	16
17-Apr-89	41	11.90	1.10	0.49	0.68	2.00	171.00	27.00	0.03	16
19-Apr-89	43	11.90	1.20	0.50	0.70	2.50	172.00	28.00	0.04	15
22-Apr-89	46	12.40	1.40	0.63	0.85	3.00	173.00	29.00	0.04	15
24-Apr-89	48	13.20	1.50	0.75	1.00	3.45	174.00	30.00	0.04	15
27-Apr-89	51	14.40	1.70	0.80	1.10	3.50	174.00	30.00	0.04	14
02-May-89	56	14.40	2.00	1.00	1.20	3.70	174.00	30.00	0.04	14
04-May-89	58	15.40	2.20	1.20	1.50	3.80	174.00	30.00	0.04	14
11-May-89	65	17.70	2.70	1.60	2.00	4.00	175.00	31.00	0.04	14
15-May-89	69	19.00	2.80	2.00	2.20	4.00	176.00	32.00	0.04	14
17-May-89	71	20.10	2.90	2.07	2.30	4.20	176.00	32.00	0.04	14
19-May-89	73	21.40	3.00	2.10	2.50	4.30	177.00	33.00	0.04	15
22-May-89	76	22.20	3.10	2.30	2.60	4.40	178.00	34.00	0.04	15
25-May-89	79	22.70	3.20	2.40	2.80	4.50	178.00	34.00	0.04	15
29-May-89	83	23.40	3.40	2.80	2.90	4.50	178.00	34.00	0.04	16
01-Jun-89	86	23.40	3.50	2.90	3.10	4.50	179.00	35.00	0.04	16
03-Jun-89	88	23.40	3.80	3.10	3.30	4.80	179.00	35.00	0.04	16
05-Jun-89	90	23.40	4.00	3.40	3.50	5.00	182.00	38.00	0.05	17
08-Jun-89	93	23.40	4.10	3.50	3.70	5.00	181.00	37.00	0.05	17
13-Jun-89	98	25.90	4.10	3.50	3.80	5.00	182.00	38.00	0.05	18
16-Jun-89	101	25.90	4.10	3.60	3.80	6.00	EOF	EOF	EOF	18
20-Jun-89	105	25.90	4.20	3.70	3.80	7.00				18
22-Jun-89	107	25.90	4.40	4.00	3.90	7.50				18
26-Jun-89	111	25.90	4.60	4.15	3.90	7.50				18
29-Jun-89	114	28.00	4.70	4.30	4.00	7.50				18
03-Jul-89	118	28.00	5.10	4.60	4.20	7.50				19
05-Jul-89	120	28.00	5.10	4.70	4.40	EOF				19
10-Jul-89	125	28.00	5.10	5.00	4.50					19
12-Jul-89	127	28.00	5.10	5.00	4.80					19
17-Jul-89	132	28.00	5.50	5.20	4.80					19
19-Jul-89	134	30.40	5.50	5.40	5.00					20
21-Jul-89	136	30.40	6.00	5.60	5.00		eof			20
25-Jul-89	140	30.40	6.00	5.70	5.20					20
31-Jul-89	146	32.80	6.00	5.80	5.50					20
03-Aug-89	149	32.80	6.00	6.00	5.50					20
08-Aug-89	154	33.50	6.00	6.00	5.50					20
16-Aug-89	162	34.50	6.50	6.00	5.50					21
21-Aug-89	167	35.40	7.00	6.00	5.50					21
23-Aug-89	169	35.40	7.00	6.00	5.50					21

28-Aug-89	174	36.20	7.50	6.50	6.00			21
30-Aug-89	176	36.20	8.00	6.50	6.00			21
04-Sep-89	181	36.20	8.50	6.50	6.50			21
08-Sep-89	185	37.60	8.50	7.00	6.50			26
11-Sep-89	188	38.90	9.00	eof	7.00			26
13-Sep-89	190	38.90	9.00		7.00			26
18-Sep-89	195	40.90	9.50		7.00			25
25-Sep-89	202	42.10	10.00		7.00			25
28-Sep-89	205	42.60	10.50		7.50			25
05-Oct-89	212	43.60	11.00		8.00			25
10-Oct-89	217	45.20	eof	eof	eof	eof	eof	25
13-Oct-89	220	46.20						25
16-Oct-89	223	48.20						25
18-Oct-89	225	49.80						25
24-Oct-89	231	49.80						25
30-Oct-89	237	50.70	eof	eof	eof	eof	eof	25

STATION K2

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 256	STRK.STRS HS 166	DIP STRS HS 117	VRT.STRS MS 058	CLSR. RDNG COM 04	CLCTD CLSR (mm)	STRAIN	CLSR. COM
17-Feb-89										
24-Feb-89										
28-Feb-89										
07-Mar-89	0	0.00	0.00	0.00	0.00	0.00	224.00	0.00	0.00	17
13-Mar-89	6	2.30	0.00	0.00		0.00	219.00	5.00	0.01	16
16-Mar-89	9	4.40	0.09	0.04		0.00	215.00	9.00	0.01	16
21-Mar-89	14	5.50	0.28	0.08		0.00	213.00	11.00	0.02	16
30-Mar-89	23	8.40	0.85	0.11		0.05	210.00	14.00	0.02	15
05-Apr-89	29	9.50	1.00	0.15		0.34	208.00	16.00	0.03	15
10-Apr-89	34	10.80	1.90	0.17		0.60	203.00	21.00	0.03	15
12-Apr-89	36	10.80	2.40	0.20		0.80	201.00	23.00	0.04	15
17-Apr-89	41	11.90	2.65	0.24		1.00	200.00	24.00	0.04	15
19-Apr-89	43	11.90	2.80	0.26		2.10	200.00	24.00	0.04	15
22-Apr-89	46	12.40	3.00	0.30		3.00	200.00	24.00	0.04	14
24-Apr-89	48	13.20	3.40	0.36	0.00	3.20	199.00	25.00	0.04	14
27-Apr-89	51	14.40	3.80	0.45		4.00	196.00	28.00	0.04	14
02-May-89	56	14.40	4.20	0.65		4.60	195.00	29.00	0.05	14
04-May-89	58	15.40	4.60	0.85		5.00	194.00	30.00	0.05	14
11-May-89	65	17.70	5.50	1.20		5.20	192.00	32.00	0.05	14
15-May-89	69	19.00	6.50	1.50		5.20	191.00	33.00	0.05	14
17-May-89	71	20.10	7.00	1.70	0.00	5.20	190.00	34.00	0.05	14
19-May-89	73	21.40	8.00	2.00	eof	5.50	156.00	35.00	0.06	14
22-May-89	76	22.20	8.10	2.40		5.50	157.00	37.00	0.06	14
25-May-89	79	22.70	8.20	2.80		5.60	159.00	38.00	0.06	14
29-May-89	83	23.40	8.60	3.00		5.80	160.00	40.00	0.06	14
01-Jun-89	86	23.40	9.00	3.50		6.00	162.00	45.00	0.07	14
03-Jun-89	88	23.40	9.20	3.80		7.00	167.00	49.00	0.08	14
05-Jun-89	90	23.40	9.50	3.80		8.00	171.00	51.00	0.08	
08-Jun-89	93	23.40	9.80	4.00		9.00	173.00	59.00	0.09	
13-Jun-89	98	25.90	10.00	4.00		10.00	181.00	60.00	0.10	
16-Jun-89	101	25.90	10.00	4.00		11.00	182.00	63.00	0.10	
20-Jun-89	105	25.90	10.50	4.50		11.00	185.00	64.00	0.10	
22-Jun-89	107	25.90	11.00	4.50		11.00	186.00	65.00	0.10	
26-Jun-89	111	25.90	11.50	4.50		11.50	187.00	66.00	0.10	
29-Jun-89	114	28.00	11.50	4.50		11.50	188.00	70.00	0.11	
03-Jul-89	118	28.00	12.00	5.00		12.00	192.00	76.00	0.12	
05-Jul-89	120	28.00	12.50	5.00		12.00	19[illegible].00	76.00	0.12	
10-Jul-89	125	28.00	13.00	5.50		12.50	198.00	76.00	0.12	
12-Jul-89	127	28.00	13.50	5.50		12.50	198.00	77.00	0.12	
17-Jul-89	132	28.00	13.50	6.00		13.00	199.00	78.00	0.12	
19-Jul-89	134	30.40	14.00	6.00		13.00	200.00	81.00	0.13	
21-Jul-89	136	30.40	14.00	6.00	eof	13.50	203.00	82.00	0.13	
25-Jul-89	140	30.40	14.00	6.00		13.50	204.00	83.00	0.13	
31-Jul-89	146	32.80	14.50	6.50		13.50	205.00	84.00	0.13	
03-Aug-89	149	32.80	15.00	7.00		14.00	206.00	85.00	0.13	
08-Aug-89	154	33.50	16.00	7.00		14.50	207.00	88.00	0.14	
16-Aug-89	162	34.50	16.50	8.00		15.00	210.00	91.00	0.14	
21-Aug-89	167	35.40	17.00	8.00		15.50	213.00	92.00	0.15	
23-Aug-89	169	35.40	17.00	8.00		15.50	214.00	94.00	0.15	
28-Aug-89	174	36.20	18.00	8.50		15.50	216.00	96.00	0.15	
30-Aug-89	176	36.20	19.00	8.50		15.50	21[illegible].00	97.00	0.15	
04-Sep-89	181	36.20	20.00	9.00		16.00	219.00	98.00	0.16	

08-Sep-89	185	37.60	20.50	9.50		16.50	268.00	104.00	0.17
11-Sep-89	188	38.90	21.00	10.00		17.00	262.00	106.00	0.17
13-Sep-89	190	38.80	21.00	eof		EOF	260.00	108.00	0.17
18-Sep-89	195	40.90	22.00				258.00	112.00	0.18
25-Sep-89	202	42.10	23.00				254.00	113.00	0.18
28-Sep-89	205	42.60	23.00	eof	eof	eof	253.00	113.00	0.18
05-Oct-89	212	43.60	23.50				253.00	113.00	0.18
10-Oct-89	217	45.20	23.50				253.00	113.00	0.18
13-Oct-89	220	46.20	24.00				253.00	114.00	0.18
16-Oct-89	223	48.20	24.00				252.00	114.00	0.18
18-Oct-89	225	49.80	24.50			0.00	252.00	115.00	0.18
24-Oct-89	231	49.80	25.00				251.00	115.00	0.18
30-Oct-89	237	50.70	25.50				251.00	116.00	0.18
02-Nov-89	240	51.80	26.00				250.00	116.00	0.18
06-Nov-89	244	51.60	26.50				250.00	116.00	0.18
08-Nov-89	246	52.40	27.00				250.00	118.00	0.19
13-Nov-89	251	56.40	27.50				248.00	118.00	0.19
20-Nov-89	258	60.20	28.00				248.00	119.00	0.19
23-Nov-89	261	62.20	29.00				247.00	119.00	0.19
01-Dec-89	269	62.70	30.00				247.00	119.00	0.19
12-Dec-89	280	64.20	30.50				247.00	121.00	0.19
21-Dec-89	289	65.20	31.50				245.00	121.00	0.19
28-Dec-89	296	66.20	31.50				245.00	121.00	0.19
04-Jan-90	303	67.20	32.00				245.00	122.00	0.19
08-Jan-90	307	69.70	32.00				244.00	122.00	0.19
15-Jan-90	314	70.20	32.00	eof	eof	eof	244.00	122.00	0.19

STATION K3

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 191	STRK.STRS HS 194	DIP STRS HS 198	VRT.STRS NTCM 20-6 TWIN	CLSR. RDNG CM 029	CLCTD CLSR (mm)	STRAIN	CLSR. NTCM
17-Feb-89										
24-Feb-89										
28-Feb-89										
07-Mar-89	0	0.00	0.00	0.00	0.00	0.00	250.00	0.00	0.00	16
13-Mar-89	6	2.30	0.00	0.00	0.00		248.00	2.00	0.00	15
16-Mar-89	9	4.40	0.00	0.00	0.00		245.00	5.00	0.01	15
21-Mar-89	14	5.50	0.02	0.00	0.00		241.00	9.00	0.01	15
30-Mar-89	23	8.40	0.06	0.01	0.02		240.00	10.00	0.01	14
[illegible]-Apr-89	29	9.50	0.11	0.04	0.05		240.00	10.00	0.01	14
10-Apr-89	34	10.80	0.16	0.05	0.07		240.00	10.00	0.01	14
12-Apr-89	36	10.80	0.22	0.07	0.08		239.00	11.00	0.01	14
17-Apr-89	41	11.90	0.26	0.07	0.09		239.00	11.00	0.01	14
19-Apr-89	43	11.90	0.35	0.08	0.10		238.00	12.00	0.01	14
22-Apr-89	46	12.40	0.48	0.08	0.11		238.00	12.00	0.01	14
24-Apr-89	48	13.20	0.53	0.09	0.12	0.00	237.00	13.00	0.02	14
27-Apr-89	51	14.40	0.65	0.10	0.13		235.00	15.00	0.02	13
02-May-89	56	14.40	0.80	0.12	0.15		234.00	16.00	0.02	13
04-May-89	58	15.40	1.00	0.16	0.18	1.00	234.00	16.00	0.02	13
11-May-89	65	17.70	1.50	0.19	0.21	1.80	233.00	17.00	0.02	13
15-May-89	69	19.00	1.80	0.20	0.26	2.00	232.00	18.00	0.02	13
17-May-89	71	20.10	2.00	0.22	0.29	2.10	232.00	18.00	0.02	13
19-May-89	73	21.40	2.20	EOF	0.32	2.20	170.00	18.00	0.02	13
22-May-89	76	22.20	2.40		0.36	2.30	169.00	19.00	0.02	13
25-May-89	79	22.70	2.40		0.38	2.40	168.00	20.00	0.02	13
29-May-89	83	23.40	2.50		0.40	2.50	165.00	23.00	0.03	13
01-Jun-89	86	23.40	2.50		0.45	2.50	162.00	26.00	0.03	13
03-Jun-89	88	23.40	2.50		0.46	2.50	158.00	30.00	0.04	13
05-Jun-89	90	23.40	2.60		0.46	2.60	153.00	35.00	0.04	13
08-Jun-89	93	23.40	2.80		0.46	2.80	153.00	35.00	0.04	13
13-Jun-89	98	25.90	2.90		0.47	2.90	152.00	36.00	0.04	13
16-Jun-89	101	25.90	3.00		0.60	3.00	143.00	45.00	0.05	13
20-Jun-89	105	25.90	3.30		0.65	3.00	132.00	56.00	0.07	
22-Jun-89	107	25.90	3.40		0.69	3.10	131.00	57.00	0.07	
26-Jun-89	111	25.90	3.50		0.76	3.30	131.00	57.00	0.07	
29-Jun-89	114	28.00	3.60		0.80	3.50	EOF			
03-Jul-89	118	28.00	3.90		0.84	3.70				
05-Jul-89	120	28.00	4.10		0.90	4.00				
10-Jul-89	125	28.00	4.40		0.94	4.50				
12-Jul-89	127	28.00	4.50		0.96	EOF				
17-Jul-89	132	28.00	4.50		1.90					
19-Jul-89	134	30.40	4.50		EOF					
21-Jul-89	136	30.40	4.50							
25-Jul-89	140	30.40	4.50							
31-Jul-89	146	32.80	4.50							
03-Aug-89	149	32.80	4.50							
08-Aug-89	154	33.50	4.80							
16-Aug-89	162	34.50	5.00							
21-Aug-89	167	35.40	5.50							
23-Aug-89	169	35.40	6.00							
28-Aug-89	174	36.20	EOF	EOF	EOF	EOF	EOF			

STATION K3

STATION L1

#USING "A4" &"A5" C/R #

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 179	STRK.STRS HS 180	DIP STRS SSM 24	VRT.STRS	CLSR. RDNG NTCM 31 #	CLCTO CLSR (mm)	STRAIN 770mm #	CLS N
27-Apr-89							#		#	
04-May-89							#		#	
11-May-89	0	0.0	0.0	0.0	0.0	0.0	#	0.0	0.0 #	
15-May-89							#		#	
17-May-89							#		#	
22-May-89							#		#	
25-May-89							#		#	
30-May-89	0.0	0.0	0.0	0.0	0.0		208.0 #	0.0	0.00 #	
02-Jun-89	3.0	1.0	0.3	0.1	0.1		199.0 #	9.0	0.01 #	
05-Jun-89	6.0	1.0	0.4	0.1	0.2		192.0 #	16.0	0.02 #	
07-Jun-89	8.0	1.0	0.5	0.1	0.2		186.0 #	22.0	0.03 #	
08-Jun-89	9.0	2.0	0.9	0.1	0.4		185.0 #	23.0	0.03 #	
09-Jun-89	10.0	2.0	1.0	0.1	0.6		182.0 #	26.0	0.03 #	
12-Jun-89	13.0	2.0	1.8	0.2	0.8		175.0 #	33.0	0.04 #	
16-Jun-89	17.0	3.0	2.9	0.3	1.0		167.0 #	41.0	0.05 #	
20-Jun-89	21.0	3.0	3.3	0.3	1.5		164.0 #	44.0	0.06 #	
22-Jun-89	23.0	4.0	3.5	0.4	1.6		159.0 #	49.0	0.06 #	
26-Jun-89	27.0	4.0	4.0	0.4	2.0		158.0 #	50.0	0.06 #	
29-Jun-89	30.0	4.0	4.5	0.5	2.2		156.0 #	52.0	0.07 #	
03-Jul-89	34.0	5.0	5.0	0.7	2.5		152.0 #	56.0	0.07 #	
05-Jul-89	36.0	5.0	EOF	0.7	2.6		150.0 #	58.0	0.08 #	
10-Jul-89	41.0	5.0		0.8	2.8		148.0 #	60.0	0.08 #	
12-Jul-89	43.0	5.0		1.0	3.1		147.0 #	61.0	0.08 #	
17-Jul-89	48.0	5.0		1.0	3.2		145.0 #	63.0	0.08 #	
19-Jul-89	50.0	5.0		1.2	3.4		145.0 #	63.0	0.08 #	
21-Jul-89	52.0	6.0		1.4	3.6		EOF #	66.0	0.09 #	
25-Jul-89	56.0	6.0		1.5	3.8		#	68.0	0.09 #	
31-Jul-89	62.0	6.0		1.8	4.2		#	75.0	0.10 #	
03-Aug-89	65.0	6.0		2.0	4.4		#	85.0	0.11 #	
08-Aug-89	70.0	6.0		2.5	4.5		#	96.0	0.12 #	
16-Aug-89	78.0	6.0		[illegible]	4.6		#	101.0	0.13 #	
21-Aug-89	83.0	7.0		3.2	5.0		#	121.0	0.16 #	
23-Aug-89	85.0	7.0		3.3	5.0		#	126.0	0.16 #	
26-Aug-89	88.0	7.0		3.6	5.0		#	133.0	0.17 #	
29-Aug-89	91.0	7.6		4.0	5.5		#	137.0	0.18 #	
04-Sep-89	97.0	7.6		4.5	6.0		#	151.0	0.20 #	
08-Sep-89	101.0	9.1		5.2	7.0		#	161.0	0.21 #	
11-Sep-89	104.0	11.4		6.0	7.0		#	169.0	0.22 #	
13-Sep-89	106.0	12.4		7.0	7.5		#	173.0	0.22 #	
18-Sep-89	111.0	13.9	EOF	8.0	7.5		#	178.0	0.23 #	
25-Sep-89	118.0	16.8		8.5	8.5		#	185.0	0.24 #	
29-Sep-89	122.0	16.8		9.0	9.0		#	190.0	0.25 #	
04-Oct-89	127.0	18.7		9.5	9.5		EOF #	191.0	0.25 #	
09-Oct-89	132.0	20.8		10.0	10.0		#	194.0	0.25 #	
12-Oct-89	135.0	22.3		10.5	10.5		#	195.0	0.25 #	
16-Oct-89	139.0	25.0		11.0	11.0		#	199.0	0.26 #	
18-Oct-89	141.0	25.0		12.0	11.5		#	201.0	0.26 #	
24-Oct-89	147.0	25.8		13.0	12.5		#	203.0	0.26 #	
30-Oct-89	153.0	28.2		13.5	13.5		#	204.0	0.26 #	
02-Nov-89	156.0	31.2		14.0	14.0		#	205.0	0.27 #	

06-Nov-89	160.0	35.2		14.5	14.5	#	210.0	0.27 #
08-Nov-89	162.0	38.5		14.5	15.0	#	212.0	0.28 #
10-Nov-89	164.0	39.5		14.5	15.5	#	215.0	0.28 #
13-Nov-89	167.0	40.5		15.0	16.0	#	218.0	0.28 #
15-Nov-89	169.0	40.5		15.0	16.5	#	221.0	0.29 #
21-Nov-89	175.0	43.5		16.0	17.5	#	222.0	0.29 #
29-Nov-89	183.0	47.0		17.0	18.0	#	223.0	0.29 #
05-Dec-89	189.0	47.0		18.0	eof	#	225.0	0.29 #
14-Dec-89	198.0	48.3				#	227.0	0.29 #
26-Dec-89	210.0	48.8				#	230.0	0.30 #
04-Jan-90	219.0	49.1				#	233.0	0.30 #
08-Jan-90	223.0	50.6				#	238.0	0.31 #
15-Jan-90	230.0	51.3	eof	eof	eof	EOF #	eof	eof #

STATION L2

DATE	DAYS	FACE ADVNC (m)	VRT. STRS HS 174	STRK.STRS HS 183	DIP STRS HS 172	VRT.STRS MS 058	CLSR. RDNG NTCM 30	CLCTD CLSR (mm)	STRAIN 670(mm)	CLSR NTC
27-Apr-89										
04-May-89										
11-May-89	0	0.0	0.0	0.0	0.0	0		0.0	0.00	
15-May-89									0.00	
17-May-89									0.00	
22-May-89									0.00	
25-May-89									0.00	
30-May-89	0.0	0.0	0.0	0.0	0.0		235.0	0.0	0.00	
02-Jun-89	3.0	1.0	0.1	0.0			231.0	4.0	0.01	
05-Jun-89	6.0	1.0	0.1	0.1			225.0	10.0	0.01	
07-Jun-89	8.0	1.0	0.2	0.1			219.0	16.0	0.02	
08-Jun-89	9.0	2.0	0.2	0.1			214.0	21.0	0.03	
09-Jun-89	10.0	2.0	0.2	0.1			209.0	26.0	0.04	
12-Jun-89	13.0	2.0	0.3	0.[illegible]	0.0		202.0	33.0	0.05	
16-Jun-89	17.0	3.0	0.4	0.2			191.0	44.0	0.07	
20-Jun-89	21.0	3.0	0.5	0.2			186.0	49.0	0.07	
22-Jun-89	23.0	4.0	0.6	0.2			183.0	52.0	0.08	
26-Jun-89	27.0	4.0	0.8	0.2			182.0	53.0	0.08	
29-Jun-89	30.0	4.0	1.0	0.3			181.0	54.0	0.08	
03-Jul-89	34.0	5.0	1.2	0.4	0.0		180.0	55.0	0.08	
05-Jul-89	36.0	5.0	1.4	0.6			180.0	55.0	0.08	
10-Jul-89	41.0	5.0	1.5	0.6			180.0	55.0	0.08	
12-Jul-89	43.0	5.0	1.7	0.6			180.0	55.0	0.08	
17-Jul-89	48.0	5.0	2.0	0.7			180.0	55.0	0.08	
19-Jul-89	50.0	5.0	2.0	0.7	0.0		180.0	55.0	0.08	
21-Jul-89	52.0	6.0	2.5	0.8	1.0		EOF			
25-Jul-89	56.0	6.0	3.0	0.9	2.0					
31-Jul-89	62.0	6.0	3.5	1.0	3.0					
03-Aug-89	65.0	6.0	4.0	1.3	3.5					
08-Aug-89	70.0	6.0	5.0	1.5	4.0					
16-Aug-89	78.0	6.0	6.0	1.8	4.3					
21-Aug-89	83.0	7.0	7.0	2.1	4.3					
23-Aug-89	85.0	7.0	7.5	2.5	4.5					
26-Aug-89	88.0	7.0	7.5	2.6	4.5					
29-Aug-89	91.0	7.6	8.0	2.8	4.5					
04-Sep-89	97.0	7.6	8.0	3.5	5.0					
08-Sep-89	101.0	9.1	8.5	4.0	5.5					
11-Sep-89	104.0	11.4	9.0	4.2	6.0					
13-Sep-89	106.0	12.4	10.0	4.5	6.5					
18-Sep-89	111.0	13.9	10.5	4.8	7.0					
25-Sep-89	118.0	16.8	11.5	5.6	8.0					
29-Sep-89	122.0	16.8	13.0	6.0	8.5					
04-Oct-89	127.0	18.7	14.0	7.5	8.5					
09-Oct-89	132.0	20.8	15.0	EOF	9.0					
12-Oct-89	135.0	22.3	16.0		9.5		EOF			
16-Oct-89	139.0	25.0	17.0		10.0					
18-Oct-89	141.0	25.0	17.5		10.5					
24-Oct-89	147.0	25.8	18.0		12.0					
30-Oct-89	153.0	28.2	18.0		13.0					
02-Nov-89	156.0	31.2	18.5		14.0					

06-Nov-89	160.0	35.2	19.0		14.5	
08-Nov-89	162.0	38.5	19.5		14.5	
10-Nov-89	164.0	39.5	20.0		14.5	
13-Nov-89	167.0	40.5	20.0		15.0	
15-Nov-89	169.0	40.5	20.0		15.0	
21-Nov-89	175.0	43.5	20.0		15.5	
29-Nov-89	183.0	47.0	20.0		16.0	
05-Dec-89	189.0	47.0	20.0		16.5	
14-Dec-89	198.0	48.3	20.0		17.0	
26-Dec-89	210.0	48.8	20.0		eof	
04-Jan-90	219.0	49.1	20.0			
08-Jan-90	223.0	50.6	20.0			
15-Jan-90	230.0	51.3	eof	EOF	eof	EOF

STATION L3

DATE	DAYS	FACE ADVNC (m)	VRT. STRS SSM 93	STRK.STRS SSM 91	DIP STRS SSM 59	VRT.STRS MS 041	CLSR. RDNG NTCM 41	CLCTD CLSR (mm)	STRAIN 680(mm)	CLSR NTC
27-Apr-89										
04-May-89										
11-May-89	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
15-May-89										
17-May-89										
22-May-89										
25-May-89										
30-May-89	0.0	0.0	0.0			0.0	216.0	0.0	0.00	
02-Jun-89	3.0	1.0	0.0			0.2	212.0	4.0	0.01	
05-Jun-89	6.0	1.0	0.0			0.5	209.0	7.0	0.01	
07-Jun-89	8.0	1.0	0.0			0.7	207.0	9.0	0.01	
08-Jun-89	9.0	2.0	0.1			0.8	206.0	10.0	0.01	
09-Jun-89	10.0	2.0	0.1			0.8	201.0	15.0	0.02	
12-Jun-89	13.0	2.0	0.2			0.9	201.0	15.0	0.02	
16-Jun-89	17.0	3.0	0.3			0.9	197.0	19.0	0.03	
20-Jun-89	21.0	3.0	0.4			0.9	197.0	19.0	0.03	
22-Jun-89	23.0	4.0	0.5			0.9	195.0	21.0	0.03	
26-Jun-89	27.0	4.0	0.6			0.9	193.0	23.0	0.03	
29-Jun-89	30.0	4.0	0.8			0.9	192.0	24.0	0.04	
03-Jul-89	34.0	5.0	1.0			1.0	187.0	29.0	0.04	
05-Jul-89	36.0	5.0	1.2			1.2	185.0	31.0	0.05	
10-Jul-89	41.0	5.0	1.4			1.4	185.0	31.0	0.05	
12-Jul-89	43.0	5.0	1.6			1.5	185.0	31.0	0.05	
17-Jul-89	48.0	5.0	1.8			1.8	185.0	31.0	0.05	
19-Jul-89	50.0	5.0	2.0	0.1	0.1	2.1	185.0	31.0	0.05	
21-Jul-89	52.0	6.0	2.5	0.1	0.1	2.5	184.0	32.0	0.05	
25-Jul-89	56.0	6.0	2.8	0.1	0.1	3.0	182.0	34.0	0.05	
31-Jul-89	62.0	6.0	3.0	0.2	0.2	3.2	179.0	37.0	0.05	
03-Aug-89	65.0	6.0	3.2	0.2	0.2	3.5	179.0	37.0	0.05	
08-Aug-89	70.0	6.0	3.7	0.2	0.5	3.8	178.0	38.0	0.06	
16-Aug-89	78.0	6.0	4.6	0.3	0.8	4.0	173.0	43.0	0.06	
21-Aug-89	83.0	7.0	4.9	0.4	1.0	4.2	172.0	44.0	0.06	
23-Aug-89	85.0	7.0	5.1	0.4	2.0	4.8	172.0	44.0	0.06	
26-Aug-89	88.0	7.0	5.2	0.5	2.5	5.0	172.0	44.0	0.06	
29-Aug-89	91.0	7.6	5.3	0.6	2.5	5.0	171.0	45.0	0.07	
04-Sep-89	97.0	7.6	6.0	0.8	3.0	5.5	169.0	47.0	0.07	
08-Sep-89	101.0	9.1	6.3	1.1	3.5	6.0	165.0	51.0	0.08	
11-Sep-89	104.0	11.4	6.5	1.3	4.5	7.0	162.0	54.0	0.08	
13-Sep-89	106.0	12.4	7.0	1.5	5.0	8.0	161.0	55.0	0.08	
18-Sep-89	111.0	13.9	7.5	1.6	5.5	9.0	160.0	56.0	0.08	
25-Sep-89	118.0	16.8	8.0	EOF	6.0	10.0	159.0	57.0	0.08	
29-Sep-89	122.0	16.8	8.5		6.5	10.5	158.0	58.0	0.09	
04-Oct-89	127.0	18.7	9.0		6.5	11.0	157.0	59.0	0.09	
09-Oct-89	132.0	20.8	EOF		6.5	eof	156.0	60.0	0.09	
12-Oct-89	135.0	22.3			6.5		156.0	60.0	0.09	
16-Oct-89	139.0	25.0			6.5		155.0	61.0	0.09	
18-Oct-89	141.0	25.0			6.5		154.0	62.0	0.09	
24-Oct-89	147.0	25.8	eof	eof	EOF	eof	154.0	62.0	0.09	
30-Oct-89	153.0	28.2					154.0	62.0	0.09	
02-Nov-89	156.0	31.2					154.0	62.0	0.09	

06-Nov-89	160.0	35.2					153.0	63.0	0.09
08-Nov-89	162.0	38.5					153.0	63.0	0.09
10-Nov-89	164.0	39.5					153.0	63.0	0.09
13-Nov-89	167.0	40.5					153.0	63.0	0.09
15-Nov-89	169.0	40.5					152.0	64.0	0.09
21-Nov-89	175.0	43.5					eof		
29-Nov-89	183.0	47.0							
05-Dec-89	189.0	47.0							
14-Dec-89	198.0	48.3							
26-Dec-89	210.0	48.8							
04-Jan-90	219.0	49.1							
08-Jan-90	223.0	50.6							
15-Jan-90	230.0	51.3	eof	eof	EOF	eof	eof		

STATION M1

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DATE	DAYS	FACE ADV (m)	VRT.STRS NTSM 57	STRK.STRS NTSM 56	DIP STRS NTSM 58	MAX MIN NTSM 73	CLSR. RDN NTCM 22	CLCTD CLS (mm)	STRAIN 710mm	CLSR. RDN NTCM 61	CLCTD CLS (mm)	STRAIN 700(mm)
21-Sep-89	0	0.00	0.00	0.02	0.00	0.00	487.00	0.00	0.00	468.00	0.00	0.00
22-Sep-89	1.00	0.40	0.10	0.02	0.00	0.00	475.00	12.00	0.02	458.00	10.00	0.01
25-Sep-89	4.00	1.40	0.30	[illegible]	0.10	0.50	471.00	16.00	0.02	450.00	18.00	0.03
26-Sep-89	5.00	1.40	0.75	[illegible]	0.25	0.80	462.00	25.00	0.04	446.00	22.00	0.03
27-Sep-89	6.00	2.20	1.00	0.28	0.29	1.00	455.00	32.00	0.05	439.00	29.00	0.04
28-Sep-89	7.00	3.20	1.50	0.46	0.57	1.50	447.00	40.00	0.06	433.00	35.00	0.05
02-Oct-89	11.00	5.20	1.90	0.85	0.83	3.00	438.00	49.00	0.07	423.00	45.00	0.06
04-Oct-89	13.00	7.30	2.25	1.20	1.10	4.00	432.00	55.00	0.08	416.00	52.00	0.07
06-Oct-89	15.00	8.30	3.10	2.06	2.30	5.00	424.00	63.00	0.09	409.00	59.00	0.08
09-Oct-89	18.00	11.50	4.00	2.45	2.85	6.00	416.00	71.00	0.10	400.00	68.00	0.10
12-Oct-89	21.00	13.50	5.50	2.90	3.50	7.50	405.00	82.00	0.12	392.00	76.00	0.11
16-Oct-89	25.00	14.50	7.00	3.50	4.00	8.50	396.00	91.00	0.13	384.00	84.00	0.12
19-Oct-89	28.00	16.70	8.50	4.00	4.50	10.00	390.00	97.00	0.14	372.00	96.00	0.14
23-Oct-89	32.00	17.50	10.00	5.00	5.50	13.00	386.00	101.00	0.14	367.00	101.00	0.14
25-Oct-89	34.00	18.50	11.00	6.00	6.00	14.00	385.00	102.00	0.14	365.00	103.00	0.15
27-Oct-89	36.00	19.40	12.50	7.00	7.00	15.00	384.00	103.00	0.15	363.00	105.00	0.15
30-Oct-89	39.00	19.40	eof	7.50	7.50	16.50	383.00	104.00	0.15	361.00	107.00	0.15
01-Nov-89	41.00	19.40		8.00	8.00	18.00	382.00	105.00	0.15	358.00	110.00	0.16
03-Nov-89	43.00	19.40		8.50	8.50	18.50	381.00	106.00	0.15	355.00	113.00	0.16
06-Nov-89	46.00	21.00		9.00	9.00	19.00	379.00	108.00	0.15	351.00	117.00	0.17
08-Nov-89	48.00	22.10		9.50	9.00	20.50	375.00	112.00	0.16	248.00	220.00	0.31
13-Nov-89	53.00	23.20		10.00	9.50	22.50	373.00	114.00	0.16	346.00	122.00	0.17
15-Nov-89	55.00	24.20		10.50	10.00	24.00	370.00	117.00	0.16	346.00	122.00	0.17
17-Nov-89	57.00	24.20		11.00	10.50	25.00	368.00	119.00	0.17	346.00	122.00	0.17
21-Nov-89	61.00	26.00		12.00	11.50	eof	366.00	121.00	0.17	346.00	122.00	0.17
24-Nov-89	64.00	28.30		13.00	12.00		364.00	123.00	0.17	346.00	122.00	0.17
28-Nov-89	68.00	31.80		14.00	13.00		363.00	124.00	[illegible]	346.00	122.00	0.17
02-Dec-89	72.00	33.70		15.00	14.00		362.00	125.00	0.18	346.00	122.00	0.17
04-Dec-89	74.00	35.20		16.00	15.50		362.00	125.00	0.18	346.00	122.00	0.17
08-Dec-89	78.00	37.00	eof	eof	17.00		362.00	125.00	0.18	346.00	122.00	0.17
12-Dec-89	82.00	38.20			eof		362.00	125.00	0.18	346.00	122.00	0.17
15-Dec-89	85.00	41.10					362.00	125.00	0.18	346.00	122.00	0.17
18-Dec-89	88.00	41.10					362.00	125.00	0.18	346.00	122.00	0.17
22-Dec-89	92.00	43.50					362.00	125.00	0.18	346.00	122.00	0.17
26-Dec-89	96.00	43.50					eof			eof		
29-Dec-89	99.00	44.20										
03-Jan-90	104.00	44.70										
08-Jan-90	109.00	45.20										
10-Jan-90	111.00	46.90										
12-Jan-90	113.00	46.90										
15-Jan-90	116.00	47.20	eof	eof	eof	eof						
18-Jan-90	119.00	47.20										
22-Jan-90	123.00	48.90										
26-Jan-90	127.00	49.40										
30-Jan-90	131.00	49.90										
05-Feb-90	137.00	51.00										
09-Feb-90	141.00	51.00										
12-Feb-90	144.00	53.00										
16-Feb-90	148.00	56.00					eof			eof		
20-Feb-90	152.00	57.00										
28-Feb-90	160.00	61.00										
12-Mar-90	172.00	65.60										
21-Mar-90	181.00	69.40										

29-Mar-90	189.00	71.90								
02-Apr-90	193.00	74.20	eof	eof	eof	eof				
10-Apr-90	201.00	76.20								
19-Apr-90	210.00	79.80								
03-May-90	224.00	83.80								
14-May-90	235.00	87.10								
04-Jun-90	256.00	93.00								
18-Jun-90	270.00	99.00								
05-Jul-90	287.00	104.50								
25-Jul-90	307.00	107.20								
01-Aug-90	314.00	107.20								
16-Aug-90	329.00	111.50								
30-Aug-90	343.00	117.50								
03-Sep-90	347.00	123.50								
06-Sep-90	350.00	125.90	eof	eof	eof	eof	eof			eof

STATION M2

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DATE	DAYS	FACE ADV (m)	VRT. STRS NTSM 95	STRK.STRS NTSM 92	DIP STRS NTSM 90	MAX MIN NTSM 84	CLSR. RDNG NTCM 60	CLCTD CLS (mm)	STRAIN 715(mm)	CLSR. RDNG NTCM 57	CLCTD CLS (mm)	STRAIN 720(mm)
21-Sep-89	0	0.00	0.00	0.00	0.00	0.00	460.00	0.00	0.00	463.00	0.00	0.00
22-Sep-89	1.00	0.40	0.00	0.00	0.00	0.00	457.00	3.00	0.00	459.00	4.00	0.01
25-Sep-89	4.00	1.40	0.00	0.00	0.02	0.00	453.00	7.00	0.01	453.00	10.00	0.01
26-Sep-89	5.00	1.40	0.09	0.00	0.06	0.50	446.00	14.00	0.02	449.00	14.00	0.02
27-Sep-89	6.00	2.20	0.12	0.02	0.08	0.80	440.00	20.00	0.03	442.00	21.00	0.03
28-Sep-89	7.00	3.20	0.19	0.05	0.12	1.00	437.00	23.00	0.03	436.00	27.00	0.04
02-Oct-89	11.00	5.20	0.41	0.10	0.27	1.50	430.00	30.00	0.04	425.00	38.00	0.05
04-Oct-89	13.00	7.30	0.60	0.14	0.35	2.00	418.00	42.00	0.06	415.00	48.00	0.07
06-Oct-89	15.00	8.30	0.95	0.20	0.64	2.50	407.00	53.00	0.07	406.00	57.00	0.08
09-Oct-89	18.00	11.50	1.65	0.37	1.00	2.50	399.00	61.00	0.09	400.00	63.00	0.09
12-Oct-89	21.00	13.50	2.35	0.58	1.40	3.00	387.00	73.00	0.10	396.00	67.00	0.09
16-Oct-89	25.00	14.50	2.80	0.70	1.85	4.00	380.00	80.00	0.11	390.00	73.00	0.10
19-Oct-89	28.00	16.70	3.20	1.05	1.90	4.50	375.00	85.00	0.12	382.00	81.00	0.11
23-Oct-89	32.00	17.50	3.60	1.55	2.30	5.00	372.00	88.00	0.12	380.00	83.00	0.12
25-Oct-89	34.00	18.50	4.20	1.75	3.00	5.50	370.00	90.00	0.13	379.00	84.00	0.12
27-Oct-89	36.00	19.40	5.50	2.50	3.50	6.00	369.00	91.00	0.13	378.00	85.00	0.12
30-Oct-89	39.00	19.40	6.50	3.50	4.00	7.00	368.00	92.00	0.13	377.00	86.00	0.12
01-Nov-89	41.00	19.40	7.50	4.80	4.50	8.00	366.00	94.00	0.13	376.00	87.00	0.12
03-Nov-89	43.00	19.40	9.00	5.50	5.00	9.00	365.00	95.00	0.13	375.00	88.00	0.12
06-Nov-89	46.00	21.00	10.00	6.00	5.00	9.50	365.00	95.00	0.13	374.00	89.00	0.12
08-Nov-89	48.00	22.10	11.00	6.00	5.50	10.00	363.00	97.00	0.14	372.00	91.00	0.13
13-Nov-89	53.00	23.20	12.00	6.50	6.00	11.00	362.00	98.00	0.14	370.00	93.00	0.13
15-Nov-89	55.00	24.20	13.00	7.00	6.00	12.00	361.00	99.00	0.14	369.00	94.00	0.13
17-Nov-89	57.00	24.20	14.00	7.50	eof	13.00	358.00	102.00	0.14	366.00	97.00	0.13
21-Nov-89	61.00	26.00	15.50	8.00		eof	355.00	105.00	0.15	364.00	99.00	0.14
24-Nov-89	64.00	28.30	16.50	8.00			351.00	109.00	0.15	360.00	103.00	0.14
28-Nov-89	68.00	31.80	17.50	8.50			348.00	112.00	0.16	358.00	105.00	0.15
02-Dec-89	72.00	33.70	18.00	9.00			342.00	118.00	0.17	352.00	111.00	0.15
04-Dec-89	74.00	35.20	18.50	9.00			339.00	121.00	0.17	347.00	116.00	0.16
08-Dec-89	78.00	37.00	18.50	9.50			339.00	121.00	0.17	345.00	118.00	0.16
12-Dec-89	82.00	38.20	eof	10.00			339.00	121.00	0.17	345.00	118.00	0.16
15-Dec-89	85.00	41.10		10.50			339.00	121.00	0.17	344.00	119.00	0.17
18-Dec-89	88.00	41.10		10.50			338.00	122.00	0.17	344.00	119.00	0.17
22-Dec-89	92.00	43.50		11.00			338.00	122.00	0.17	343.00	120.00	0.17
26-Dec-89	96.00	43.50		11.00			338.00	122.00	0.17	342.00	121.00	0.17
29-Dec-89	99.00	44.20		11.50			338.00	122.00	0.17	342.00	121.00	0.17
03-Jan-90	104.00	44.70		12.00			338.00	122.00	0.17	342.00	121.00	0.17
08-Jan-90	109.00	45.20		13.00			338.00	122.00	0.17	342.00	121.00	0.17
10-Jan-90	111.00	46.90		13.50			338.00	122.00	0.17	342.00	121.00	0.17
12-Jan-90	113.00	46.90		13.50			337.00	123.00	0.17			
15-Jan-90	116.00	47.20	eof	14.00	eof	eof	337.00	123.00	0.17	eof		
18-Jan-90	119.00	47.20		14.00			336.00	124.00	0.17			
22-Jan-90	123.00	48.90		15.00			333.00	127.00	0.18			
26-Jan-90	127.00	49.40		15.50			332.00	128.00	0.18			
30-Jan-90	131.00	49.90		16.00			332.00	128.00	0.18			
05-Feb-90	137.00	51.00		eof				460.00	0.64			

STATION M2

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DATE	DAYS	FACE ADV (m)	VRT. STRS NTSM 95	STRK.STRS NTSM 92	DIP STRS NTSM 90	MAX MIN NTSM 84	CLSR. RDNG NTCM 60	CLCTD CLS (mm)	STRAIN 715(mm)	CLSR. RDNG NTCM 57	CLCTD CLS (mm)	STRAIN 720(mm)
21-Sep-89	0	0.00	0.00	0.00	0.00	0.00	460.00	0.00	0.00	463.00	0.00	0.00
22-Sep-89	1.00	0.40	0.00	0.00	0.00	0.00	457.00	3.00	0.00	459.00	4.00	0.01
25-Sep-89	4.00	1.40	0.00	0.00	0.02	0.00	453.00	7.00	0.01	453.00	10.00	0.01
26-Sep-89	5.00	1.40	0.09	0.00	0.06	0.50	446.00	14.00	0.02	449.00	14.00	0.02
27-Sep-89	6.00	2.20	0.12	0.02	0.08	0.80	440.00	20.00	0.03	442.00	21.00	0.03
28-Sep-89	7.00	3.20	0.19	0.05	0.12	1.00	437.00	23.00	0.03	436.00	27.00	0.04
02-Oct-89	11.00	5.20	0.41	0.10	0.27	1.50	430.00	30.00	0.04	425.00	38.00	0.05
04-Oct-89	13.00	7.30	0.60	0.14	0.35	2.00	418.00	42.00	0.06	415.00	48.00	0.07

06-Oct-89	15.00	8.30	0.95	0.20	0.64	2.50	407.00	53.00	0.07	406.00	57.00	0.08
09-Oct-89	18.00	11.50	1.65	0.37	1.00	2.50	399.00	61.00	0.09	400.00	63.00	0.09
12-Oct-89	21.00	13.50	2.35	0.58	1.40	3.00	387.00	73.00	0.10	396.00	67.00	0.09
16-Oct-89	25.00	14.50	2.80	0.70	1.85	4.00	380.00	80.00	0.11	390.00	73.00	0.10
19-Oct-89	28.00	16.70	3.20	1.05	1.90	4.50	375.00	85.00	0.12	382.00	81.00	0.11
23-Oct-89	32.00	17.50	3.80	1.55	2.30	5.00	372.00	88.00	0.12	380.00	83.00	0.12
25-Oct-89	34.00	18.50	4.20	1.75	3.00	5.50	370.00	90.00	0.13	379.00	84.00	0.12
27-Oct-89	36.00	19.40	5.50	2.50	3.50	6.00	369.00	91.00	0.13	378.00	85.00	0.12
30-Oct-89	39.00	19.40	6.50	3.50	4.00	7.00	368.00	92.00	0.13	377.00	86.00	0.12
01-Nov-89	41.00	19.40	7.50	4.80	4.50	8.00	366.00	94.00	0.13	376.00	87.00	0.12
03-Nov-89	43.00	19.40	9.00	5.50	5.00	9.00	365.00	95.00	0.13	375.00	88.00	0.12
06-Nov-89	46.00	21.00	10.00	6.00	5.00	9.50	365.00	95.00	0.13	374.00	89.00	0.12
08-Nov-89	48.00	22.10	11.00	6.00	5.50	10.00	363.00	97.00	0.14	372.00	91.00	0.13
13-Nov-89	53.00	23.20	12.00	6.50	6.00	11.00	362.00	98.00	0.14	370.00	93.00	0.13
15-Nov-89	55.00	24.20	13.00	7.00	6.00	12.00	361.00	99.00	0.14	369.00	94.00	0.13
17-Nov-89	57.00	24.20	14.00	7.50	eof	13.00	358.00	102.00	0.14	366.00	97.00	0.13
21-Nov-89	61.00	26.00	15.50	8.00		eof	355.00	105.00	0.15	364.00	99.00	0.14
24-Nov-89	64.00	28.30	16.50	8.00			351.00	109.00	0.15	360.00	103.00	0.14
28-Nov-89	68.00	31.60	17.50	8.50			348.00	112.00	0.16	358.00	105.00	0.15
02-Dec-89	72.00	33.70	18.00	9.00			342.00	118.00	0.17	352.00	111.00	0.15
04-Dec-89	74.00	35.20	18.50	9.00			339.00	121.00	0.17	347.00	116.00	0.16
08-Dec-89	78.00	37.00	18.50	9.50			339.00	121.00	0.17	345.00	118.00	0.16
12-Dec-89	82.00	38.20	eof	10.00			339.00	121.00	0.17	345.00	118.00	0.16
15-Dec-89	85.00	41.10		10.50			339.00	121.00	0.17	344.00	119.00	0.17
18-Dec-89	88.00	41.10		10.50			338.00	122.00	0.17	344.00	119.00	0.17
22-Dec-89	92.00	43.50		11.00			338.00	122.00	0.17	343.00	120.00	0.17
26-Dec-89	96.00	43.50		11.00			338.00	122.00	0.17	342.00	121.00	0.17
29-Dec-89	99.00	44.20		11.50			338.00	122.00	0.17	342.00	121.00	0.17
03-Jan-90	104.00	44.70		12.00			338.00	122.00	0.17	342.00	121.00	0.17
08-Jan-90	109.00	45.20		13.00			338.00	122.00	0.17	342.00	121.00	0.17
10-Jan-90	111.00	46.90		13.50			338.00	122.00	0.17	342.00	121.00	0.17
12-Jan-90	113.00	46.90		13.50			337.00	123.00	0.17			
15-Jan-90	116.00	47.20	eof	14.00	eof	eof	337.00	123.00	0.17	eof		
18-Jan-90	119.00	47.20		14.00			336.00	124.00	0.17			
22-Jan-90	123.00	48.90		15.00			333.00	127.00	0.18			
26-Jan-90	127.00	49.40		15.50			332.00	128.00	0.18			
30-Jan-90	131.00	49.90		16.00			332.00	128.00	0.18			
05-Feb-90	137.00	51.00		eof				460.00	0.64			

STATION M3

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DATE	DAYS	FACE ADV (m)	VRT. STRS NTSM 67	STRK.STRS NTSM 66	DIP STRS NTSM 65	MAX MIN NTSM 82	CLSR. RDN NTCM 59	CLCTD CLS (mm)	STRAIN 710(mm)	CLSR. RDN NTCM 35	CLCTD CLS (mm)	STRAIN 705(mm)
21-Sep-89	0	0.00	0.00	0.00	0.00	0.00	475.00	0.00	0.00	457.00	0.00	0.00
22-Sep-89	1.00	0.40	0.00	0.00	0.00	0.00	471.00	4.00	0.01	453.00	4.00	0.01
25-Sep-89	4.00	1.40	0.29	0.05	0.10	0.00	468.00	7.00	0.01	450.00	7.00	0.01
26-Sep-89	5.00	1.40	0.55	0.09	0.17	0.50	467.00	8.00	0.01	446.00	11.00	0.02
27-Sep-89	6.00	2.20	0.70	0.12	0.22	1.00	462.00	13.00	0.02	442.00	15.00	0.02
28-Sep-89	7.00	3.20	0.93	0.19	0.29	1.00	459.00	16.00	0.02	437.00	20.00	0.03
02-Oct-89	11.00	5.20	1.20	0.25	0.47	2.00	453.00	22.00	0.03	428.00	29.00	0.04
04-Oct-89	13.00	7.30	1.70	0.45	0.62	2.00	449.00	26.00	0.04	417.00	40.00	0.06
06-Oct-89	15.00	8.[illegible]	2.40	0.78	0.99	3.00	437.00	38.00	0.05	409.00	48.00	0.07
09-Oct-89	18.00	11.50	2.95	1.10	1.35	3.50	428.00	47.00	0.07	399.00	58.00	0.08
12-Oct-89	21.00	13.50	4.05	1.45	1.65	4.00	420.00	55.00	0.08	394.00	63.00	0.09
16-Oct-89	25.00	14.50	5.00	1.65	1.80	5.00	414.00	61.00	0.09	387.00	70.00	0.10
19-Oct-89	28.00	16.70	6.00	2.10	2.20	6.00	405.00	70.00	0.10	382.00	75.00	0.11
23-Oct-89	32.00	17.50	7.00	2.60	2.85	6.50	398.00	77.00	0.11	379.00	78.00	0.11
25-Oct-89	34.00	18.50	8.00	2.90	3.20	7.00	395.00	79.00	0.11	378.00	79.00	0.11
27-Oct-89	36.00	19.40	8.50	3.30	3.70	7.50	392.00	83.00	0.12	376.00	81.00	0.11
30-Oct-89	39.00	19.40	9.00	4.00	3.80	8.00	388.00	87.00	0.12	375.00	82.00	0.12
01-Nov-89	41.00	19.40	9.50	4.50	4.20	8.50	385.00	90.00	0.13	375.00	82.00	0.12
03-Nov-89	43.00	19.40	10.00	4.70	4.45	9.00	383.00	92.00	0.13	372.00	85.00	0.12
06-Nov-89	46.00	21.00	10.50	5.00	4.80	9.50	379.00	96.00	0.14	370.00	87.00	0.12
08-Nov-89	48.00	22.10	11.00	5.50	5.00	10.00	376.00	99.00	0.14	369.00	88.00	0.12
13-Nov-89	53.00	23.20	11.50	5.80	5.30	11.00	372.00	103.00	0.15	368.00	89.00	0.13
15-Nov-89	55.00	24.20	12.00	6.00	5.50	12.00	369.00	106.00	0.15	365.00	92.00	0.13
17-Nov-89	57.00	24.20	13.50	7.00	6.00	13.00	366.00	109.00	0.15	361.00	96.00	0.14
21-Nov-89	61.00	26.00	14.50	7.50	7.00	13.50	364.00	111.00	0.16	360.00	97.00	0.14
24-Nov-89	64.00	28.30	16.00	8.00	8.00	14.00	360.00	115.00	0.16	357.00	100.00	0.14
28-Nov-89	68.00	31.60	16.50	8.50	8.50	15.00	358.00	117.00	0.16	356.00	101.00	0.14
02-Dec-89	72.00	33.70	17.00	9.50	9.00	16.00	357.00	118.00	0.17	355.00	102.00	0.14
04-Dec-89	74.00	35.20	18.00	11.00	9.50	17.00	355.00	120.00	0.17	354.00	103.00	0.15
0[illegible]-Dec-89	78.00	37.00	19.50	12.50	10.00	eof	353.00	122.00	0.17	354.00	103.00	0.15
12-Dec-89	82.00	38.20	20.50	14.00	11.00		350.00	125.00	0.18	353.00	104.00	0.15
15-Dec-89	85.00	41.10	21.50	14.50	eof		348.00	127.00	0.18	353.00	104.00	0.15
18-Dec-89	88.00	41.10	22.50	15.00			347.00	128.00	0.18	352.00	105.00	0.15
22-Dec-89	92.00	43.50	23.50	15.50			347.00	128.00	0.18	351.00	106.00	0.15
26-Dec-89	96.00	43.50	24.00	16.00			346.00	129.00	0.18	350.00	107.00	0.15
29-Dec-89	99.00	44.20	24.50	16.50			346.00	129.00	0.18	349.00	108.00	0.15
03-Jan-90	104.00	44.70	25.50	17.50			346.00	129.00	0.18	345.00	112.00	0.16
08-Jan-90	109.00	45.20	26.50	18.50			345.00	130.00	0.18	341.00	116.00	0.16
10-Jan-90	111.00	46.90	27.50	19.50			344.00	131.00	0.18	338.00	119.00	0.17
12-Jan-90	113.00	46.90	28.00	20.00			341.00	134.00	0.19	337.00	120.00	0.17
15-Jan-90	116.00	47.20	29.00	20.50	0.00	eof	338.00	137.00	0.19	336.00	121.00	0.17
18-Jan-90	119.00	47.20	30.00	21.00			337.00	138.00	0.19	335.00	122.00	0.17
22-Jan-90	123.00	48.90	31.00	21.50			336.00	139.00	0.20	333.00	124.00	0.18
26-Jan-90	127.00	49.40	32.00	22.00			336.00	139.00	0.20	332.00	125.00	0.18
30-Jan-90	131.00	49.90	32.50	23.50			336.00	139.00	0.20	332.00	125.00	0.18
05-Feb-90	137.00	51.00	34.00	24.50			336.00	139.00	0.20			
09-Feb-90	141.00	51.00	35.00	25.50			336.00	139.00	0.20			
12-Feb-90	144.00	53.00	36.00	26.00			336.00	139.00	0.20			
16-Feb-90	148.00	56.00	eof	27.00			336.00	139.00	0.20			
20-Feb-90	152.00	57.00		27.50			336.00	139.00	0.20			
28-Feb-90	160.00	61.00		30.00			336.00	139.00	0.20			
12-Mar-90	172.00	65.60		32.50			334.00	141.00	0.20			
21-Mar-90	181.00	69.40		34.00			329.00	146.00	0.21			
29-Mar-90	189.00	71.90	eof	36.00	eof	eof	328.00	147.00	0.21	eof	eof	eof
02-Apr-90	193.00	74.20		37.00			327.00	148.00	0.21			
10-Apr-90	201.00	76.20		38.50			325.00	150.00	0.21			

19-Apr-90	210.00	79.80		40.00			324.00	151.00	0.21			
03-May-90	224.00	83.80		42.00			323.00	152.00	0.21			
14-May-90	235.00	87.10		44.00			318.00	157.00	0.22			
04-Jun-90	256.00	93.00		48.00			314.00	161.00	0.23			
18-Jun-90	270.[illegible]	99.00		50.00			312.00	163.00	0.23			
05-Jul-90	287.00	104.50		54.00			311.00	164.00	0.23			
25-Jul-90	307.00	107.20		56.50			311.00	164.00	0.23			
01-Aug-90	314.00	107.20		57.50			311.00	164.00	0.23			
16-Aug-90	329.00	111.50		58.50			311.00	164.00	0.23			
30-Aug-90	343.00	117.50		60.00			311.00	164.00	0.23			
03-Sep-90	347.00	123.50		61.00			311.00	164.00	0.23			
06-Sep-90	350.00	125.90	eof	62.00	eof	eof	311.00	164.00	0.23	eof	eof	eof

STATION M4

DATE	DAYS	FACE ADV (m)	VRT. STRS HS 165	STRK.STRS HS 170	DIP STRS HS 235	MAX MIN NIL	CLSR. RDNCL NTCM 81	CTD CLS (mm)	STRAIN 720(mm)	CLSR. RDNCL NTCM 116	CTD CLS (mm)	STRAIN 705(mm)
21-Sep-89	0	0.00										
22-Sep-89	1.00	0.40										
25-Sep-89	4.00	1.40										
26-Sep-89	5.00	1.40	0.00	0.00	0.00	nil	456.00	0.00	0.00	338.00	0.00	0.00
27-Sep-89	6.00	2.20	0.07	0.06	0.00		443.00	13.00	0.02	326.00	12.00	0.02
28-Sep-89	7.00	3.20	0.12	0.07	0.00		436.00	20.00	0.03	321.00	17.00	0.02
02-Oct-89	11.00	5.20	0.30	0.08	0.00		428.00	28.00	0.04	318.00	20.00	0.03
04-Oct-89	13.00	7.30	0.75	0.10	0.00		421.00	35.00	0.05	314.00	24.00	0.03
06-Oct-89	15.00	8.30	1.00	0.11	0.10		415.00	41.00	0.06	307.00	31.00	0.04
09-Oct-89	18.00	11.50	1.50	0.15	0.40		410.00	46.00	0.06	299.00	39.00	0.06
12-Oct-89	21.00	13.50	2.20	0.21	0.50		407.00	49.00	0.07	294.00	44.00	0.06
16-Oct-89	25.00	14.50	2.90	0.24	0.60		401.00	55.00	0.08	287.00	51.00	0.07
19-Oct-89	28.00	16.70	3.80	0.31	0.80		395.00	61.00	0.08	278.00	60.00	0.09
23-Oct-89	32.00	17.50	4.80	0.49	1.00	nil	391.00	65.00	0.09	276.00	62.00	0.09
25-Oct-89	34.00	18.50	5.40	0.66	1.20		390.00	66.00	0.09	275.00	63.00	0.09
27-Oct-89	36.00	19.40	6.30	0.82	1.60		389.00	67.00	0.09	275.00	63.00	0.09
30-Oct-89	39.00	19.40	7.70	0.90	1.70		388.00	68.00	0.09	274.00	64.00	0.09
01-Nov-89	41.00	19.40	8.00	1.20	1.80		387.00	69.00	0.10	273.00	65.00	0.09
03-Nov-89	43.00	19.40	8.98	1.30	2.00		387.00	69.00	0.10	272.00	66.00	0.09
06-Nov-89	46.00	21.00	9.20	1.40	2.30		386.00	70.00	0.10	271.00	67.00	0.10
08-Nov-89	48.00	22.10	9.70	1.50	2.40		386.00	70.00	0.10	270.00	68.00	0.10
13-Nov-89	53.00	23.20	10.00	1.80	2.50		386.00	70.00	0.10	269.00	69.00	0.10
15-Nov-89	55.00	24.20	eof	2.00	3.00		383.00	73.00	0.10	266.00	72.00	0.10
17-Nov-89	57.00	24.20		2.60	4.00		382.00	74.00	0.10	265.00	73.00	0.10
21-Nov-89	61.00	26.00		3.00	4.30		381.00	75.00	0.10	263.00	75.00	0.11
24-Nov-89	64.00	28.30		3.40	4.50		381.00	75.00	0.10	262.00	76.00	0.11
28-Nov-89	68.00	31.60		3.80	5.00		381.00	75.00	0.10	261.00	77.00	0.11
02-Dec-89	72.00	33.70		4.20	5.50		381.00	75.00	0.10	261.00	77.00	0.11
04-Dec-89	74.00	35.20		4.40	6.00		380.00	76.00	0.11	260.00	78.00	0.11
08-Dec-89	78.00	37.00		4.70	7.00		378.00	78.00	0.11	259.00	79.00	0.11
12-Dec-89	82.00	38.20		5.20	8.00		375.00	81.00	0.11	258.00	80.00	0.11
15-Dec-89	85.00	41.10		5.50	8.50		375.00	81.00	0.11	257.00	81.00	0.11
18-Dec-89	88.00	41.10		5.80	9.00		375.00	81.00	0.11	257.00	81.00	0.11
22-Dec-89	92.00	43.50		6.00	9.50		375.00	81.00	0.11	257.00	81.00	0.11
26-Dec-89	96.00	43.50		6.10	10.00		375.00	81.00	0.11	256.00	82.00	0.12
29-Dec-89	99.00	44.20		6.60	10.50		375.00	81.00	0.11	256.00	82.00	0.12
03-Jan-90	104.00	44.70	eof	eof	11.00	eof	375.00	81.00	0.11	255.00	83.00	0.12
08-Jan-90	109.00	45.20			11.50		375.00	81.00	0.11	255.00	83.00	0.12
10-Jan-90	111.00	46.90			12.00		375.00	81.00	0.11	255.00	83.00	0.12
12-Jan-90	113.00	46.90			12.50		375.00	81.00	0.11	254.00	84.00	0.12
15-Jan-90	116.00	47.20	eof	eof	13.50		374.00	82.00	0.11	253.00	85.00	0.12
18-Jan-90	119.00	47.20			14.00		373.00	83.00	0.12	253.00	85.00	0.12
22-Jan-90	123.00	48.90			14.50		372.00	84.00	0.12	253.00	85.00	0.12
26-Jan-90	127.00	49.40			15.00		372.00	84.00	0.12	252.00	86.00	0.12
30-Jan-90	131.00	49.90			16.00		372.00	84.00	0.12	251.00	87.00	0.12
05-Feb-90	137.00	51.00			16.30		370.00	86.00	0.12	250.00	88.00	0.12
09-Feb-90	141.00	51.00			16.50		370.00	86.00	0.12	250.00	88.00	0.12
12-Feb-90	144.00	53.00			16.80		370.00	86.00	0.12	250.00	88.00	0.12
16-Feb-90	148.00	56.00			17.00		370.00	86.00	0.12	250.00	88.00	0.12
20-Feb-90	152.00	57.00			18.00		370.00	86.00	0.12	250.00	88.00	0.12
28-Feb-90	160.00	61.00			20.00		370.00	86.00	0.12	250.00	88.00	0.12
12-Mar-90	172.00	65.60			21.50		369.00	87.00	0.12	250.00	88.00	0.12
21-Mar-90	181.00	69.40			24.00		369.00	87.00	0.12	250.00	88.00	0.12

29-Mar-90	189.00	71.90	eof	eof	26.00	eof	369.00	87.00	0.12	250.00	88.00	0.12
02-Apr-90	193.00	74.20			26.50		369.00	87.00	0.12	250.00	88.00	0.12
10-Apr-90	201.00	76.20			27.00		368.00	88.00	0.12	250.00	88.00	0.12
19-Apr-90	210.00	79.80			28.00		365.00	91.00	0.13	250.00	88.00	0.12
03-May-90	224.00	83.80			30.50		360.00	96.00	0.13	248.00	90.00	0.13
14-May-90	235.00	87.10			34.00		355.00	101.00	0.14	245.00	93.00	0.13
04-Jun-90	256.00	93.00			38.00		350.00	106.00	0.15	243.00	95.00	0.13
18-Jun-90	270.00	99.00			40.50		349.00	107.00	0.15	240.00	98.00	0.14
05-Jul-90	287.00	104.50			44.50		348.00	108.00	0.15	238.00	100.00	0.14
25-Jul-90	307.00	107.20			46.00		347.00	109.00	0.15	237.00	101.00	0.14
01-Aug-90	314.00	107.20			48.00		346.00	110.00	0.15	237.00	101.00	0.14
16-Aug-90	329.00	111.50			50.50		346.00	110.00	0.15	237.00	101.00	0.14
30-Aug-90	343.00	117.50			52.85		346.00	110.00	0.15	237.00	101.00	0.14
03-Sep-90	347.00	123.50			57.00		346.00	110.00	0.15	237.00	101.00	0.14
06-Sep-90	350.00	125.90	eof	eof	60.00	eof	346.00	110.00	0.15	237.00	101.00	0.14

STATION M5

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DATE	DAYS	FACE ADV (m)	VRT. STRS SSM 55	STRK.STRS SSM 94	DIP STRS NTSM 59	MAX MIN NIL	CLSR. NTCM 77	RDNCLCTD CLS (mm)	STRAIN 880(mm)	CLSR. NTCM 107	RDNCLCTD CLS (mm)	STRAIN 975(mm)
21-Sep-89	0	0.00										
22-Sep-89	1.00	0.40										
25-Sep-89	4.00	1.40										
26-Sep-89	5.00	1.40										
27-Sep-89	6.00	2.20										
28-Sep-89	7.00	3.20	0.00	0.00	0.00		438.00	0.00	0.00	341.00	0.00	0.00
02-Oct-89	11.00	5.20	0.00	0.00	0.00		429.00	9.00	0.01	335.00	6.00	0.01
04-Oct-89	13.00	7.30	0.00	0.00	0.00		421.00	17.00	0.02	329.00	12.00	0.01
06-Oct-89	15.00	8.30	0.02	0.02	0.00		415.00	23.00	0.03	325.00	16.00	0.02
09-Oct-89	18.00	11.50	0.12	0.09	0.00		409.00	29.00	0.03	319.00	22.00	0.02
12-Oct-89	21.00	13.50	0.24	0.12	0.00		404.00	34.00	0.04	312.00	29.00	0.03
16-Oct-89	25.00	14.50	0.38	0.17	0.00		400.00	38.00	0.04	306.00	35.00	0.04
19-Oct-89	28.00	16.70	0.73	0.19	0.05		399.00	39.00	0.04	300.00	41.00	0.04
23-Oct-89	32.00	17.50	0.95	0.39	0.10		397.00	41.00	0.05	295.00	46.00	0.05
25-Oct-89	34.00	18.50	1.19	0.47	0.20		397.00	41.00	0.05	eof		
27-Oct-89	36.00	19.40	2.10	0.58	0.35		396.00	42.00	0.05			
30-Oct-89	39.00	19.40	2.50	0.70	0.58		395.00	43.00	0.05			
01-Nov-89	41.00	19.40	2.75	0.76	0.80		395.00	43.00	0.05			
03-Nov-89	43.00	19.40	3.35	0.85	0.90		393.00	45.00	0.05			
06-Nov-89	46.00	21.00	3.80	0.99	1.00		392.00	46.00	0.05			
08-Nov-89	48.00	22.10	4.00	1.10	1.20		390.00	48.00	0.05			
13-Nov-89	53.00	23.20	4.50	1.20	1.60		388.00	50.00	0.06			
15-Nov-89	55.00	24.20	5.00	1.25	2.00		385.00	53.00	0.06			
17-Nov-89	57.00	24.20	5.50	1.55	2.40		385.00	53.00	0.06			
21-Nov-89	61.00	26.00	6.00	1.75	2.90		385.00	53.00	0.06			
24-Nov-89	64.00	28.30	7.00	1.80	3.20		385.00	53.00	0.06			
28-Nov-89	68.00	31.60	7.50	2.15	3.60		385.00	53.00	0.06			
02-Dec-89	72.00	33.70	8.00	2.45	4.00		385.00	53.00	0.06			
04-Dec-89	74.00	35.20	8.50	2.55	4.40		385.00	53.00	0.06			
08-Dec-89	78.00	37.00	9.00	2.85	4.50		385.00	53.00	0.06			
12-Dec-89	82.00	38.20	9.50	3.00	4.70		385.00	53.00	0.06			
15-Dec-89	85.00	41.10	10.00	3.30	4.80		385.00	53.00	0.06			
18-Dec-89	88.00	41.10	10.50	3.50	4.90		385.00	53.00	0.06	eof		
22-Dec-89	92.00	43.50	11.00	3.70	5.00		385.00	53.00	0.06			
26-Dec-89	96.00	43.50	11.50	3.80	5.20		385.00	53.00	0.06			
29-Dec-89	99.00	44.20	12.00	3.90	5.50		385.00	53.00	0.06			
03-Jan-90	104.00	44.70	12.50	4.00	5.20		385.00	53.00	0.06			
08-Jan-90	109.00	45.20	13.00	4.20	5.50		385.00	53.00	0.06			
10-Jan-90	111.00	46.90	13.50	4.40	5.80		385.00	53.00	0.06			
12-Jan-90	113.00	46.90	14.00	4.60	6.00		385.00	53.00	0.06			
15-Jan-90	116.00	47.20	14.00	4.70	6.30		384.00	54.00	0.06	eof		
18-Jan-90	119.00	47.20	14.50	4.80	6.50		384.00	54.00	0.06			
22-Jan-90	123.00	48.90	15.00	5.00	6.70		383.00	55.00	0.06			
26-Jan-90	127.00	49.40	16.00	5.20	6.80		383.00	55.00	0.06			
30-Jan-90	131.00	49.90	16.00	5.30	7.00		382.00	56.00	0.06			
05-Feb-90	137.00	51.00	17.00	5.70	7.50							
09-Feb-90	141.00	51.00	18.00	6.00								
12-Feb-90	144.00	53.00	18.50									
16-Feb-90	148.00	56.00	19.50									
20-Feb-90	152.00	57.00	20.00									

STATION M5

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INSTALLED in

PANEL 94E1 STATION N1

DATE	DAYS	FACE ADV (m)	Vert MPa NTSM 248	Strike MP NTSM 104	DIP MPa NTSM 105	MAX-MIN NTSM 169	CL/ Meter NTCM 105	CLOSURE (mm)	STRAIN 600mm	CL/ Meter NTCM 68	CLOSURE (mm)	STRAIN 670(mm)
23-Feb-90	0	0.00	0.00	0.02	0.00	0.00	300.00	0.00	0.00	300.00	0.00	0.00
26-Feb-90	3	2.10	0.00	0.00	0.00	0.00	291.00	9.00	0.02	294.00	6.00	0.01
27-Feb-90	4	3.10	0.05	0.01	0.00	0.00	287.00	13.00	0.02	294.00	6.00	0.01
28-Feb-90	5	4.30	0.05	0.04	0.00	0.00	274.00	26.00	0.04	291.00	9.00	0.01
01-Mar-90	6	5.10	0.10	0.05	0.00	0.00	274.00	26.00	0.04	291.00	9.00	0.01
05-Mar-90	10	6.20	0.25	0.10	0.00	1.00	246.00	54.00	0.09	291.00	9.00	0.01
07-Mar-90	12	6.20	0.45	0.13	0.04	1.00	235.00	65.00	0.11	291.00	9.00	0.01
09-Mar-90	14	6.90	0.65	0.19	0.05	1.00	233.00	67.00	0.11	291.00	9.00	0.01
12-Mar-90	17	8.00	0.87	0.26	0.10	2.00	232.00	68.00	0.11	291.00	9.00	0.01
14-Mar-90	19	9.30	1.00	0.42	0.19	3.00	227.00	73.00	0.12	291.00	9.00	0.01
16-Mar-90	21	10.20	2.50	0.58	0.28	3.00	225.00	75.00	0.13	291.00	9.00	0.01
19-Mar-90	24	10.70	3.50	0.78	0.50	3.50	221.00	79.00	0.13	291.00	9.00	0.01
21-Mar-90	26	11.60	4.00	0.99	0.60	4.00	220.00	80.00	0.13	291.00	9.00	0.01
26-Mar-90	31	13.60	6.00	1.35	1.05	5.00	217.00	83.00	0.14	290.00	10.00	0.01
30-Mar-90	35	16.10	6.50	1.90	1.45	6.50	216.00	84.00	0.14	288.00	12.00	0.02
02-Apr-90	38	17.00	7.00	2.00	1.65	7.00	215.00	85.00	0.14	286.00	14.00	0.02
04-Apr-90	40	18.00	8.00	2.20	2.00	7.50	213.00	87.00	0.15	285.00	15.00	0.02
06-Apr-90	42	19.00	8.50	2.60	2.10	8.00	213.00	87.00	0.15	285.00	15.00	0.02
11-Apr-90	47	20.70	9.00	2.90	2.50	9.00	212.00	88.00	0.15	285.00	15.00	0.02
17-Apr-90	53	21.30	10.00	3.15	2.70	10.00	212.00	88.00	0.15	285.00	15.00	0.02
23-Apr-90	59	22.80	11.50	3.55	3.10	11.00	212.00	88.00	0.15	285.00	15.00	0.02
25-Apr-90	61	24.80	13.00	3.95	3.60	12.00	212.00	88.00	0.15	285.00	15.00	0.02
03-May-90	69	26.60	14.50	4.50	4.25	13.50	212.00	88.00	0.15	285.00	15.00	0.02
07-May-90	73	27.70	15.50	4.60	4.65	14.50	210.00	90.00	0.15	285.00	15.00	0.02
10-May-90	76	28.90	16.50	5.10	5.10	15.00	209.00	91.00	0.15	285.00	15.00	0.02
14-May-90	80	30.00	18.00	5.40	5.80	16.50	208.00	92.00	0.15	285.00	15.00	0.02
17-May-90	83	33.10	19.00	5.60	6.50	18.00	208.00	92.00	0.15	285.00	15.00	0.02
22-May-90	88	35.00	21.00	6.00	7.50	19.50	207.00	93.00	0.16	285.00	15.00	0.02
25-May-90	91	36.10	22.00	EOF	8.00	21.00	207.00	93.00	0.16	285.00	15.00	0.02
30-May-90	96	37.40	23.50		8.50	22.00	207.00	93.00	0.16	285.00	15.00	0.02
04-Jun-90	101	37.40	25.50		9.00	23.00	206.00	94.00	0.16	285.00	15.00	0.02
07-Jun-90	104	40.30	26.50		9.50	24.50	206.00	94.00	0.16	285.00	15.00	0.02
11-Jun-90	108	41.90	27.00		10.00	25.00	206.00	94.00	0.16	285.00	15.00	0.02
14-Jun-90	111	42.90	28.50		10.50	26.00	206.00	94.00	0.16	285.00	15.00	0.02
18-Jun-90	115	42.90	30.00		11.00	27.50	206.00	94.00	0.16	285.00	15.00	0.02
20-Jun-90	117	43.90	31.50		11.50	28.50	206.00	94.00	0.16	285.00	15.00	0.02
22-Jun-90	119	43.90	32.00		12.00	29.00	205.00	95.00	0.16	284.00	16.00	0.02
26-Jun-90	123	55.70	32.60		12.00	29.50	205.00	95.00	0.16	284.00	16.00	0.02
02-Jul-90	129	50.50	36.50		13.50	32.00	205.00	95.00	0.16	284.00	16.00	0.02
10-Jul-90	137	53.30	39.00		14.50	34.50	205.00	95.00	0.16	283.00	17.00	0.03
17-Jul-90	144	55.10	42.00		15.50	37.00	205.00	95.00	0.16	283.00	17.00	0.03
23-Jul-90	150	55.10	43.00		16.00	38.50	205.00	95.00	0.16	283.00	17.00	0.03
25-Jul-90	152	55.10	46.50		17.50	40.00	205.00	95.00	0.16	281.00	19.00	0.03
27-Jul-90	154	55.10	48.00		18.50	42.00	205.00	95.00	0.16	280.00	20.00	0.03
01-Aug-90	159	55.10	50.00		19.00	44.00	205.00	95.00	0.16	279.00	21.00	0.03
06-Aug-90	164	55.10	51.00		20.00	45.50	204.00	96.00	0.16	278.00	22.00	0.03
10-Aug-90	168	57.10	52.50		20.50	47.00	204.00	96.00	0.16	278.00	22.00	0.03
16-Aug-90	174	58.10	54.00		21.00	48.00	203.00	97.00	0.16	277.00	23.00	0.03
21-Aug-90	179	60.10	55.50		21.50	49.00	203.00	97.00	0.16	276.00	24.00	0.04

24-Aug-90	182	60.10	56.50	22.00	50.50	201.00	99.00	0.17	275.00	25.00	0.04
28-Aug-90	186	60.10	57.50	22.00	51.00	200.00	100.00	0.17	274.00	26.00	0.04
03-Sep-90	192	60.10	58.00	22.50	52.00	198.00	102.00	0.17	274.00	26.00	0.04
06-Sep-90	195	60.10	59.00	23.50	53.00	196.00	104.00	0.17	274.00	26.00	0.04
10-Sep-90	199	60.10	60.00	24.00	53 50	194.00	106.00	0.18	274.00	26.00	0.04
13-Sep-90	202	61.30	eof	24.50	54.00	191.00	109.00	0.18	274.00	26.00	0.04
17-Sep-90	206	62.20		25.00	55.00	189.00	111.00	0.19	273.00	27.00	0.04
21-Sep-90	210	64.30		25.50	56.00	186.00	114.00	0.19	272.00	28.00	0.04
25-Sep-90	214	65.00		26 00	57.50	182.00	118.00	0.20	270.00	30.00	0.04

INSTALLED in
PANEL 94E1

STATION N2

DATE	DAYS	FACE ADV (m)	Vert MPa NTSM 115	Strike MP NTSM 93	DIP MPa NTSM 113	MAX-MIN NTSM 87	CL/ Meter NTCM 69	CLOSURE (mm)	STRAIN 590(mm)	CL/ Meter NTCM 76	CLOSURE (mm)	STRAIN 610(mm)
23-Feb-90	0	0.00	0.00	0.00	0.00	0.00	309.00	0.00	0.00	310.00	0.00	0.00
26-Feb-90	3	2.10	0.05	0.00	0.06	0.00	300.00	9.00	0.02	300.00	10.00	0.02
27-Feb-90	4	3.10	0.10	0.00	0.08	0.00	290.00	19.00	0.03	283.00	27.00	0.04
28-Feb-90	5	4.30	0.19	0.00	0.09	0.00	275.00	34.00	0.06	270.00	40.00	0.07
01-Mar-90	6	5.10	0.29	0.00	0.11	1.00	272.00	37.00	0.06	270.00	40.00	0.07
05-Mar-90	10	6.20	0.50	0.00	0.24	1.00	261.00	48.00	0.08	262.00	48.00	0.08
07-Mar-90	12	6.20	0.70	0.00	0.33	1.00	258.00	51.00	0.09	261.00	49.00	0.08
09-Mar-90	14	6.90	0.99	0.00	0.48	1.00	256.00	53.00	0.09	257.00	53.00	0.09
12-Mar-90	17	8.00	1.05	0.05	0.59	2.00	253.00	56.00	0.09	256.00	54.00	0.09
14-Mar-90	19	9.30	1.60	0.09	0.85	2.00	250.00	59.00	0.10	252.00	58.00	0.10
16-Mar-90	21	10.20	2.10	0.13	0.88	2.00	247.00	62.00	0.11	248.00	62.00	0.10
19-Mar-90	24	10.70	2.40	0.20	1.00	2.00	243.00	66.00	0.11	246.00	64.00	0.10
21-Mar-90	26	11.60	2.65	0.25	1.40	2.50	242.00	67.00	0.11	245.00	65.00	0.11
26-Mar-90	31	13.60	3.70	0.50	2.00	3.00	238.00	71.00	0.12	243.00	67.00	0.11
30-Mar-90	35	16.10	4.60	0.75	2.40	4.00	236.00	73.00	0.12	241.00	69.00	0.11
02-Apr-90	38	17.00	4.80	0.83	2.60	5.00	235.00	74.00	0.13	240.00	70.00	0.11
04-Apr-90	40	18.00	5.05	0.91	2.70	5.00	234.00	75.00	0.13	239.00	71.00	0.12
06-Apr-90	42	19.00	5.40	1.00	2.80	5.50	233.00	76.00	0.13	239.00	71.00	0.12
11-Apr-90	47	20.70	6.50	1.20	3.00	6.00	234.00	75.00	0.13	238.00	72.00	0.12
17-Apr-90	53	21.30	8.00	1.25	3.10	6.50	234.00	75.00	0.13	238.00	72.00	0.12
23-Apr-90	59	22.80	9.00	1.61	3.30	7.00	234.00	75.00	0.13	238.00	72.00	0.12
25-Apr-90	61	24.80	10.00	1.90	3.50	8.50	234.00	75.00	0.13	237.00	73.00	0.12
03-May-90	69	26.60	eof	2.30	4.50	9.50	233.00	76.00	0.13	237.00	73.00	0.12
07-May-90	73	27.70		2.60	5.00	10.00	231.00	78.00	0.13	234.00	76.00	0.12
10-May-90	76	28.90		2.95	5.50	11.00	229.00	80.00	0.14	229.00	81.00	0.13
14-May-90	80	30.00		3.15	EOF	11.50	228.00	81.00	0.14	228.00	82.00	0.13
17-May-90	83	33.10		3.40		12.50	227.00	82.00	0.14	228.00	82.00	0.13
22-May-90	88	35.00		3.85		13.50	226.00	83.00	0.14	228.00	82.00	0.13
25-May-90	91	36.10		4.10		14.50	226.00	83.00	0.14	228.00	82.00	0.13
30-May-90	96	37.40		4.30		15.00	226.00	83.00	0.14	228.00	82.00	0.13
04-Jun-90	101	37.40		4.85		16.50	225.00	84.00	0.14	226.00	84.00	0.14
07-Jun-90	104	40.30		5.05		17.50	225.00	84.00	0.14	225.00	85.00	0.14
11-Jun-90	108	41.90		5.50		18.00	225.00	84.00	0.14	eof	eof	eof
14-Jun-90	111	42.90		6.00		19.90	225.00	84.00	0.14			
18-Jun-90	115	42.90	eof	eof	eof	20.00	225.00	84.00	0.14			
20-Jun-90	117	43.90				21.00	225.00	84.00	0.14			
22-Jun-90	119	43.90				21.50	225.00	84.00	0.14			
26-Jun-90	123	55.70				22.00	225.00	84.00	0.14			
02-Jul-90	129	50.50				23.50	225.00	84.00	0.14			
10-Jul-90	137	53.30				26.00	225.00	84.00	0.14			
17-Jul-90	144	55.10				28.00	225.00	84.00	0.14			
23-Jul-90	150	55.10				29.00	224.00	85.00	0.14			
25-Jul-90	152	55.10				30.00	221.00	88.00	0.15			
27-Jul-90	154	55.10				32.00	220.00	89.00	0.15			
01-Aug-90	159	55.10				34.00	220.00	89.00	0.15	eof	eof	eof
06-Aug-90	164	55.10				35.50	219.00	90.00	0.15			
10-Aug-90	168	57.10	EOF	EOF	EOF	36.00	219.00	90.00	0.15			
16-Aug-90	174	58.10				37.00	219.00	90.00	0.15			
21-Aug-90	179	60.10				38.00	218.00	91.00	0.15			

24-Aug-90	182	60.10		39.50	218.00	91.00	0.15			
28-Aug-90	186	60.10		41.00	217.00	92.00	0.16			
03-Sep-90	192	60.10		42.50	217.00	92.00	0.16			
06-Sep-90	195	60.10		44.00	216.00	93.00	0.16			
10-Sep-90	199	60.10		46.00	215.00	94.00	0.16			
13-Sep-90	202	61.30		48.50	212.00	97.00	0.16			
17-Sep-90	206	62.20		50.50	200.00	109.00	0.18			
21-Sep-90	210	64.30		53.00	195.00	114.00	0.19	eof	eof	eof
25-Sep-90	214	65.00		57.00	192.00	117.00	0.20			

INSTALLED in

PANEL 94EI

STATION N3

DATE	DAYS	FACE ADV (m)	Vert MPa NTSM 120	Strike MP NTSM 121	DIP MPa NTSM 117	MAX-MIN NTSM 4	CL/ Meter NTCM 82	CLOSURE (mm)	STRAIN 760(mm)	CL/ Meter NTCM 113	CLOSURE (mm)	STRAIN 710(mm)
23-Feb-90	0	0.00	0.00	0.00	0.00	0.00	300.00	0.00	0.00	300.00	0.00	0.00
26-Feb-90	3	2.10	0.00	0.02	0.00	0.00	290.00	10.00	0.01	295.00	5.00	0.01
27-Feb-90	4	3.10	0.00	0.02	0.00	0.00	278.00	22.00	0.03	285.00	15.00	0.02
28-Feb-90	5	4.30	0.00	0.04	0.00	0.00	272.00	28.00	0.04	275.00	25.00	0.04
01-Mar-90	6	5.10	0.00	0.05	0.03	0.00	270.00	30.00	0.04	270.00	30.00	0.04
05-Mar-90	10	6.20	0.40	0.06	0.04	0.00	260.00	40.00	0.05	268.00	32.00	0.05
07-Mar-90	12	6.20	0.09	0.07	0.05	0.00	258.00	42.00	0.06	265.00	35.00	0.05
09-Mar-90	14	6.90	0.10	0.08	0.08	0.00	252.00	48.00	0.06	262.00	38.00	0.05
12-Mar-90	17	8.00	0.14	0.09	0.10	0.00	250.00	50.00	0.07	261.00	39.00	0.05
14-Mar-90	19	9.30	0.28	0.11	0.14	0.00	247.00	53.00	0.07	258.00	42.00	0.06
16-Mar-90	21	10.20	0.44	0.13	0.18	0.00	245.00	55.00	0.07	254.00	46.00	0.06
19-Mar-90	24	10.70	0.65	0.16	0.24	0.00	243.00	57.00	0.08	252.00	48.00	0.07
21-Mar-90	26	11.60	0.85	0.18	0.28	1.00	242.00	58.00	0.08	248.00	52.00	0.07
26-Mar-90	31	13.60	1.00	0.28	0.47	2.00	242.00	58.00	0.08	243.00	57.00	0.08
30-Mar-90	35	16.10	1.40	0.45	0.67	2.50	242.00	58.00	0.08	240.00	60.00	0.08
02-Apr-90	38	17.00	2.05	0.50	0.74	2.50	242.00	58.00	0.08	238.00	62.00	0.09
04-Apr-90	40	18.00	2.30	0.58	0.81	3.00	242.00	58.00	0.08	236.00	64.00	0.09
06-Apr-90	42	19.00	2.60	0.70	0.90	3.00	241.00	59.00	0.08	236.00	64.00	0.09
11-Apr-90	47	20.70	2.85	0.95	1.00	3.50	240.00	60.00	0.08	235.00	65.00	0.09
17-Apr-90	53	21.30	3.60	1.00	1.30	3.50	238.00	62.00	0.08	234.00	66.00	0.09
23-Apr-90	59	22.80	3.90	1.20	1.50	4.00	237.00	63.00	0.08	234.00	66.00	0.09
25-Apr-90	61	24.80	4.40	1.50	1.70	4.50	EOF	EOF	EOF	233.00	67.00	0.09
03-May-90	69	26.60	5.00	1.85	2.10	5.00				232.00	68.00	0.10
07-May-90	73	27.70	5.50	2.10	2.35	5.50				231.00	69.00	0.10
10-May-90	76	28.90	6.50	2.20	2.50	6.00				230.00	70.00	0.10
14-May-90	80	30.00	7.00	2.55	2.80	EOF				229.00	71.00	0.10
17-May-90	83	33.10	7.50	2.75	3.10					228.00	72.00	0.10
22-May-90	88	35.00	8.50	3.15	3.45					228.00	72.00	0.10
25-May-90	91	36.10	9.50	3.32	3.62					228.00	72.00	0.10
30-May-90	96	37.40	10.00	3.55	3.82					228.00	72.00	0.10
04-Jun-90	101	37.40	11.00	4.00	4.25					227.00	73.00	0.10
07-Jun-90	104	40.30	11.50	4.30	4.45					226.00	74.00	0.10
11-Jun-90	108	41.90	12.00	4.50	4.55					225.00	75.00	0.11
14-Jun-90	111	42.90	12.50	4.80	4.85		EOF	EOF	EOF	224.00	76.00	0.11
18-Jun-90	115	42.90	13.50	5.05	5.15					224.00	76.00	0.11
20-Jun-90	117	43.90	14.00	6.00	5.30					224.00	76.00	0.11
22-Jun-90	119	43.90	14.50	6.50	5.50					224.00	76.00	0.11
26-Jun-90	123	55.70	15.00	7.50	5.70	EOF				224.00	76.00	0.11
02-Jul-90	129	50.50	16.50	8.00	6.50					224.00	76.00	0.11
10-Jul-90	137	53.30	18.00	9.00	8.00					224.00	76.00	0.11
17-Jul-90	144	55.10	19.50	9.50	9.00					224.00	76.00	0.11
23-Jul-90	150	55.10	20.50	10.00	10.50					224.00	76.00	0.11
25-Jul-90	152	55.10	22.00	10.50	11.50					224.00	76.00	0.11
27-Jul-90	154	55.10	23.50	11.50	12.50					220.00	80.00	0.11
01-Aug-90	159	55.10	24.00	12.00	13.50	EOF	EOF	EOF	EOF	218.00	82.00	0.12
06-Aug-90	164	55.10	24.50	12.00	14.00					218.00	82.00	0.12
10-Aug-90	168	57.10	25.00	12.50	14.00					217.00	83.00	0.12
16-Aug-90	174	58.10	26.00	12.80	14.50					217.00	83.00	0.12
21-Aug-90	179	60.10	26.50	13.00	14.50					217.00	83.00	0.12

24-Aug-90	182	60.10	27.00	13.20	15.00					217.00	83.00	0.12
28-Aug-90	186	60.10	27.00	13.40	15.50					217.00	83.00	0.12
03-Sep-90	192	60.10	27.00	13.50	16.00					217.00	83.00	0.12
06-Sep-90	195	60.10	28.00	14.00	16.50					eof	eof	eof
10-Sep-90	199	60.10	29.00	14.00	17.50							
13-Sep-90	202	61.30	29.50	14.50	18.00							
17-Sep-90	206	62.20	30.00	14.50	18.00							
21-Sep-90	210	64.30	30.50	15.00	18.50	EOF	EOF	EOF	EOF			
25-Sep-90	214	65.00	31.00	15.00	19.00					eof	eof	eof

STATION P1

DATE	DAYS	FACE ADV (m)	VERT MPa MN	STRIKE MP MS	DIP MPa MP	MAX-MIN NTSM 72	CL. RIDE NTCM 101	CLOSURE (mm)	STRAIN 780mm	CL. RIDE NTCM 66	CLOSURE (mm)	STRAIN 790(mm)
23-Mar-90	0	0.00	0.00	0.00	0.00	0.00	302.00	0.00	0.00	308.00	0.00	0.00
26-Mar-90	3	1.60	0.00	0.00	0.00	0.00	294.00	8.00	0.01	301.00	7.00	0.01
27-Mar-90	4	2.50	0.00	0.00	0.00	0.00	280.00	22.00	0.03	289.00	19.00	0.02
30-Mar-90	7	4.50	0.00	0.00	0.00	0.00	275.00	27.00	0.03	284.00	24.00	0.03
02-Apr-90	10	5.50	0.00	0.00	0.00	0.00	267.00	35.00	0.04	278.00	30.00	0.04
05-Apr-90	13	6.80	0.05	0.00	0.05	0.00	260.00	42.00	0.05	271.00	37.00	0.05
10-Apr-90	18	7.70	0.10	0.05	0.10	0.00	250.00	52.00	0.07	258.00	50.00	0.06
20-Apr-90	28	9.50	0.18	0.06	0.14	0.00	241.00	61.00	0.08	251.00	57.00	0.07
25-Apr-90	33	10.00	0.22	0.08	0.16	0.00	239.00	63.00	0.08	247.00	61.00	0.08
03-May-90	41	12.60	0.26	0.11	0.20	0.00	230.00	72.00	0.09	241.00	67.00	0.08
07-May-90	45	14.30	0.59	0.17	0.26	0.00	229.00	73.00	0.09	238.00	70.00	0.09
10-May-90	48	15.00	0.78	0.24	0.30	0.00	228.00	74.00	0.09	234.00	74.00	0.09
11-May-90	49	15.00	0.88	0.25	0.31	0.00	228.00	74.00	0.09	233.00	75.00	0.09
14-May-90	52	15.00	1.00	0.30	0.36	0.00	228.00	74.00	0.09	233.00	75.00	0.09
16-May-90	54	16.70	1.15	0.34	0.41	0.00	228.00	74.00	0.10	230.00	78.00	0.10
18-May-90	56	17.90	1.30	0.41	0.48	0.00	228.00	74.00	0.11	228.00	80.00	0.10
21-May-90	59	19.80	1.50	0.47	0.57	1.00	228.00	74.00	0.11	227.00	81.00	0.10
22-May-90	60	19.80	2.20	0.60	0.94	2.00	227.00	75.00	0.12	224.00	84.00	0.11
24-May-90	62	19.80	2.30	0.64	0.99	2.50	eof	eof	0.13	223.00	85.00	0.11
29-May-90	67	19.80	2.40	0.75	1.00	2.50			0.13	222.00	86.00	0.11
30-May-90	68	21.20	2.45	0.80	1.09	2.50			0.13	221.00	87.00	0.11
04-Jun-90	73	21.70	2.80	0.93	1.15	3.00			0.13	220.00	88.00	0.11
07-Jun-90	76	22.50	3.00	1.00	1.25	3.00			0.13	219.00	89.00	0.11
13-Jun-90	82	23.90	3.10	1.05	1.35	3.00			0.14	218.00	90.00	0.11
18-Jun-90	87	24.80	3.20	1.10	1.55	3.50			0.14	218.00	90.00	0.11
21-Jun-90	90	24.80	3.55	1.15	1.60	4.00			0.14	218.00	90.00	0.11
26-Jun-90	95	27.10	4.00	1.45	1.85	4.00			0.15	218.00	90.00	0.11
29-Jun-90	98	27.90	4.25	1.55	2.00	4.30			0.15	217.00	91.00	0.12
02-Jul-90	101	27.90	4.45	1.65	2.15	4.50			0.16	217.00	93.00	0.12
04-Jul-90	103	28.70	4.60	1.75	2.30	5.00			0.16		94.94	0.12
06-Jul-90	105	30.00	4.80	1.80	2.40	5.50			0.16		94.94	0.12
10-Jul-90	109	30.00	5.00	1.90	2.45	5.80			0.16		98.67	0.12
13-Jul-90	112	30.90	5.35	2.00	2.50	6.00			0.16		99.30	0.13
16-Jul-90	115	31.80	6.00	2.05	2.55	6.10			0.17		103.16	0.13
19-Jul-90	118	32.70	6.50	2.10	2.65	6.20			0.17		104.09	0.13
24-Jul-90	123	33.80	7.00	2.20	2.85	6.30			0.17		106.99	0.14
25-Jul-90	124	33.80	[illegible]	2.25	2.90	6.50			0.17		106.99	0.14
31-Jul-90	130	35.70	8.00	2.55	3.05	7.00			0.18		111.81	0.14
02-Aug-90	132	36.50	8.50	2.70	3.15	7.20	eof	eof	0.18		113.73	0.14
07-Aug-90	137	36.50	8.50	2.90	3.35	7.30			0.18		118.23	0.15
13-Aug-90	143	38.80	9.00	3.15	3.50	7.50			0.18		119.16	0.15
17-Aug-90	147	40.20	9.50	3.35	3.60	8.00			0.19		120.73	0.15
22-Aug-90	152	40.70	10.00	3.45	3.75	8.50			0.19		122.75	0.16
27-Aug-90	157	42.70	10.00	3.80	3.90	9.00			0.19		125.34	0.16
31-Aug-90	161	45.40	10.50	3.90	4.05	9.20			0.19		128.22	0.16
03-Sep-90	164	45.40	10.50	5.00	4.15	9.30			0.20		131.41	0.17
07-Sep-90	168	48.70	11.00	6.00	4.30	9.50			0.20		133.53	0.17
12-Sep-90	173	49.50	11.50	6.00	4.45	10.00			0.20		135.77	0.17
17-Sep-90	178	50.10	11.80	6.30	5.00	10.50			0.20		137.08	0.17
21-Sep-90	182	52.10	12.00	6.50	6.00	10.80			0.20		138.78	0.18
26-Sep-90	187	54.20	12.50	6.80	6.50	11.00	eof	eof	0.21	eof	140.10	0.18

01-Oct-90	192	56.00	12.80	7.00	7.00	11.50			0.21		144.05	0.18
05-Oct-90	196	57.60	13.00	7.10	7.20	12.00			0.21		146.42	0.19
11-Oct-90	202	60.00	13.50	7.30	7.50	12.50			0.22		150.14	0.19
16-Oct-90	207	61.00	14.00	7.50	7.80	12.80			0.22		150.69	0.19
23-Oct-90	214	64.00	14.30	7.80	8.00	13.00			0.22		152.68	0.19
29-Oct-90	220	66.00	14.50	8.00	8.30	14.00			0.22		154.55	0.20
06-Nov-90	228	67.90	15.00	8.50	8.50	14.30			0.22		157.77	0.20
13-Nov-90	235	70.60	15.50	9.00	9.00	14.50			0.23		159.01	0.20
21-Nov-90	243	71.00	16.00	9.20	9.30	14.80			0.23		161.30	0.20
27-Nov-90	249	74.60	16.50	9.50	9.50	15.00			0.23		164.28	0.21
05-Dec-90	257	76.40	17.00	9.80	9.80	15.80			0.23		166.02	0.21
11-Dec-90	263	78.20	17.50	10.00	10.50	16.50			0.24		168.83	0.21
17-Dec-90	269	80.40	18.00	10.50	10.60	eof	eof	eof	0.24	eof	170.50	0.22
21-Dec-90	273	80.40	18.50	11.00	10.70				0.24		172.52	0.22
31-Dec-90	283	81.40	19.00	11.50	11.00				0.24		174.95	0.22
02-Jan-91	285	81.40	19.20	11.70	11.00				0.24		177.01	0.22
08-Jan-91	291	83.30	19.50	11.80	11.30				0.25		178.38	0.23
14-Jan-91	297	86.10	19.80	11.80	11.50				0.25		179.75	0.23
17-Jan-91	300	88.60	20.00	11.90	11.70				0.25		180.75	0.23
23-Jan-91	306	90.40	20.30	12.00	12.00				0.25		182.12	0.23
28-Jan-91	311	92.20	20.50	12.00	12.30				0.25		183.21	0.23
01-Feb-91	315	92.20	20.50	12.00	12.50				0.25		184.59	0.23
04-Feb-91	318	94.00	21.00	12.20	12.80				0.02		185.00	0.23
07-Feb-91	321	94.90	21.50	12.30	12.90				0.04		186.10	0.24
12-Feb-91	326	96.60	22.00	12.50	13.00				0.06		186.81	0.24
18-Feb-91	332	96.60	22.20	12.50	13.00				0.08		186.81	0.24
26-Feb-91	340	99.50	22.30	12.50	13.00	eof	eof	eof	0.10	eof	187.91	0.24
01-Mar-91	343	102.30	22.50	12.60	13.20				0.12		188.20	0.24
06-Mar-91	348	105.10	22.60	12.80	13.30				0.14		188.63	0.24
12-Mar-91	354	105.10	22.70	12.80	13.50				0.16		190.02	0.24
18-Mar-91	360	110.00	23.00	13.00	13.80				0.18		190.02	0.24
22-Mar-91	364	111.50	23.20	13.20	14.00				0.20		190.73	0.24
26-Mar-91	368	112.80	23.50	13.30	14.20				0.22		190.73	0.24
01-Apr-91	374	113.50	24.00	13.50	14.20				0.24		191.17	0.24
08-Apr-91	381	117.60	28.50	15.50	15.50				0.26		196.69	0.25
15-Apr-91	388	117.60	28.50	15.50	15.50				0.28		198.97	0.25
22-Apr-91	395	118.70	28.50	15.50	15.50	eof	eof	eof	0.30		198.06	0.25

STATION P2

DATE	DAYS	FACE ADV (m)	VERT MPa MT	STRIKE MP MY	DIP MPA MW	MAX-MIN NTSM 79	CL. RIDE NTCM 106	CLOSURE (mm)	STRAIN 780(mm)	CL. RIDE NTCM 112	CLOSURE (mm)	STRAIN 800(mm)
23-Mar-90	0	0.00	0.00	0.00	0.00	0.00	308.00	0.00	0.00	309.00	0.00	0.00
26-Mar-90	3	1.60	0.00	0.00	0.00	0.00	300.00	8.00	0.01	300.00	9.00	0.01
27-Mar-90	4	2.50	0.00	0.00	0.00	0.00	291.00	17.00	0.02	294.00	15.00	0.02
30-Mar-90	7	4.50	0.00	0.00	0.00	0.00	285.00	23.00	0.03	285.00	24.00	0.03
02-Apr-90	10	5.50	0.00	0.00	0.00	0.00	282.00	26.00	0.03	284.00	25.00	0.03
05-Apr-90	13	6.80	0.00	0.00	0.00	0.00	266.00	42.00	0.05	276.00	33.00	0.04
10-Apr-90	18	7.70	0.05	0.05	0.05	0.00	259.00	49.00	0.06	267.00	42.00	0.05
20-Apr-90	28	9.50	0.08	0.07	0.06	0.10	250.00	58.00	0.07	260.00	49.00	0.06
25-Apr-90	33	10.00	0.12	0.08	0.07	0.40	248.00	60.00	0.08	254.00	55.00	0.07
03-May-90	41	12.60	0.24	0.12	0.10	0.50	240.00	68.00	0.09	249.00	60.00	0.08
07-May-90	45	14.30	0.52	0.18	0.15	0.80	237.00	71.00	0.09	237.00	72.00	0.09
10-May-90	48	15.00	0.74	0.22	0.20	1.10	235.00	73.00	0.09	225.00	84.00	0.11
11-May-90	49	15.00	0.85	0.24	0.23	1.20	234.00	74.00	0.09	224.00	85.00	0.11
14-May-90	52	15.00	0.98	0.26	0.25	1.40	233.00	75.00	0.10	223.00	86.00	0.11
16-May-90	54	16.70	1.10	0.30	0.29	1.50	232.00	76.00	0.10	220.00	89.00	0.11
18-May-90	56	17.90	1.20	0.35	0.35	1.70	231.00	77.00	0.10	219.00	90.00	0.11
21-May-90	59	19.80	1.45	0.43	0.44	1.90	226.	82.00	0.11	215.00	94.00	0.12
22-May-90	60	19.80	2.20	0.62	0.78	2.60	226.00	82.00	0.11	210.00	99.00	0.12
24-May-90	62	19.80	2.40	0.70	0.85	2.80	225.00	83.00	0.11	210.00	99.00	0.12
29-May-90	67	19.80	2.50	0.75	0.93	3.00	225.00	83.00	0.11	210.00	99.00	0.12
30-May-90	68	21.20	2.85	0.77	0.98	3.00	225.00	83.00	0.11	210.00	99.00	0.12
04-Jun-90	73	21.70	3.00	0.94	1.00	3.10	224.00	84.00	0.11	208.00	101.00	0.13
07-Jun-90	76	22.50	3.20	1.00	1.20	3.20	223.00	85.00	0.11	207.00	102.00	0.13
13-Jun-90	82	23.90	3.40	1.15	1.35	3.85	222.00	86.00	0.11	206.00	103.00	0.13
18-Jun-90	87	24.80	3.80	1.30	1.60	4.25	eof	eof	eof	205.00	104.00	0.13
21-Jun-90	90	24.80	3.85	1.40	1.75	4.50				204.00	105.00	0.13
26-Jun-90	95	27.10	4.45	1.80	2.00	5.05				204.00	105.00	0.13
29-Jun-90	98	27.90	4.75	1.95	2.10	5.30				203.00	106.00	0.13
02-Jul-90	101	27.90	5.00	2.05	2.20	5.50				202.00	107.00	0.13
04-Jul-90	103	28.70	5.15	2.15	2.35	5.80				201.00	108.00	0.14
06-Jul-90	105	30.00	5.30	2.35	2.45	6.00				200.00	109.00	0.14
10-Jul-90	109	30.00	6.00	2.40	2.55	6.30				199.00	110.00	0.14
13-Jul-90	112	30.90	6.50	2.45	2.60	eof	eof	eof	eof	199.00	110.00	0.14
16-Jul-90	115	31.80	7.00	2.55	2.65					198.00	111.00	0.14
19-Jul-90	118	32.70	7.50	2.65	2.75					198.00	111.00	0.14
24-Jul-90	123	33.80	8.00	2.70	2.95					197.00	112.00	0.14
25-Jul-90	124	33.80	8.00	3.05	3.00					196.00	113.00	0.14
31-Jul-90	130	35.70	8.50	3.15	3.15					196.00	113.00	0.14
02-Aug-90	132	36.50	9.00	3.25	3.25					196.00	113.00	0.14
07-Aug-90	137	36.50	9.50	3.45	3.45					196.00	113.00	0.14
13-Aug-90	143	38.80	10.00	3.70	3.70					196.00	113.00	0.14
17-Aug-90	147	40.20	10.30	3.85	3.75					196.00	113.00	0.14
22-Aug-90	152	40.70	10.50	4.10	4.10					196.00	113.00	0.14
27-Aug-90	157	42.70	11.00	4.50	4.18					196.00	113.00	0.14
31-Aug-90	161	45.40	11.50	4.65	4.30					196.00	113.00	0.14
03-Sep-90	164	45.40	12.00	4.80	4.35					195.00	114.00	0.14
07-Sep-90	168	48.70	12.20	4.86	4.50	eof	eof	eof	eof	191.00	118.00	0.15
12-Sep-90	173	49.50	12.50	5.05	4.65					188.00	121.00	0.15
17-Sep-90	178	50.10	12.80	5.10	4.75					186.00	123.00	0.15
21-Sep-90	182	52.10	13.00	5.25	4.90					185.00	124.00	0.16
26-Sep-90	187	54.20	13.50	5.45	5.05					184.00	125.00	0.16

01-Oct-90	192	56.00	14.00	5.70	5.45					184.00	125.00	0.16
05-Oct-90	196	57.60	14.30	5.80	5.60					184.00	125.00	0.16
11-Oct-90	202	60.00	14.50	6.00	5.75					184.00	125.00	0.16
16-Oct-90	207	61.00	15.00		6.00					184.00	125.00	0.16
23-Oct-90	214	64.00	15.50	eof	eof	eof	eof	eof	eof	eof	eof	eof
29-Oct-90	220	66.00	16.00									
06-Nov-90	228	67.90	16.50									
13-Nov-90	235	70.60	17.00									
21-Nov-90	243	71.00	17.50									
27-Nov-90	249	74.60	18.00									
05-Dec-90	257	76.40	18.50									
11-Dec-90	263	78.20	19.50									
17-Dec-90	269	80.40	20.00									
21-Dec-90	273	80.40	20.50									
31-Dec-90	283	81.40	21.00									
02-Jan-91	285	81.40	21.20									
08-Jan-91	291	83.30	21.50									
14-Jan-91	297	86.10	21.60									
17-Jan-91	300	88.60	21.80	eof	eof	eof	eof	eof	eof	eof	eof	eof
23-Jan-91	306	90.40	22.00									
28-Jan-91	311	92.20	22.20									
01-Feb-91	315	92.20	22.50									
04-Feb-91	318	94.00	23.00									
07-Feb-91	321	94.90	23.50									
12-Feb-91	326	96.60	24.50									
18-Feb-91	332	96.60	24.80									
26-Feb-91	340	99.50	24.90									
01-Mar-91	343	102.30	25.00									
06-Mar-91	348	105.10	25.30									
12-Mar-91	354	105.10	25.50									
18-Mar-91	360	110.00	25.80									
22-Mar-91	364	111.50	26.00									
26-Mar-91	368	112.80	26.20	eof	eof	eof	eof	eof	eof	eof	eof	eof
01-Apr-91	374	113.50	26.50									
08-Apr-91	381	117.60	28.50									
15-Apr-91	388	117.60	28.50									
22-Apr-91	395	118.70	28.50	eof	eof	eof	eof	eof	eof	eof	eof	eof

STATION P3

DATE	DAYS	FACE ADV (m)	VERT. MPA MH	STRIKE MP MK	DIP MPa MJ	MAX-MIN NTSM 88	CL. RIDE NTCM 74	CLOSURE (mm)	STRAIN 900(mm)	CL. RIDE NTCM 111	CLOSURE (mm)	STRAIN 850(mm)
23-Mar-90	0	0.00	0.00	0.00	0.00	0.00	305.00	0.00	0.00	300.00	0.00	0.00
26-Mar-90	3	1.60	0.00	0.00	0.00	0.00	300.00	5.00	0.01	289.00	11.00	0.01
27-Mar-90	4	2.50	0.00	0.00	0.00	0.00	298.00	7.00	0.01	282.00	18.00	0.02
30-Mar-90	7	4.50	0.00	0.00	0.00	0.00	292.00	13.00	0.01	273.00	27.00	0.03
02-Apr-90	10	5.50	0.00	0.00	0.00	0.00	282.00	23.00	0.03	267.00	33.00	0.04
05-Apr-90	13	6.80	0.00	0.00	0.00	0.00	274.00	31.00	0.03	257.00	43.00	0.05
10-Apr-90	18	7.70	0.05	0.00	0.00	0.00	271.00	34.00	0.04	252.00	48.00	0.06
20-Apr-90	28	9.50	0.09	0.00	0.00	0.00	260.00	45.00	0.05	237.00	63.00	0.07
25-Apr-90	33	10.00	0.12	0.00	0.05	0.00	252.00	53.00	0.06	232.00	68.00	0.08
03-May-90	41	12.60	0.19	0.00	0.06	0.00	246.00	59.00	0.07	228.00	72.00	0.08
07-May-90	45	14.30	0.27	0.00	0.08	0.00	240.00	65.00	0.07	225.00	75.00	0.09
10-May-90	48	15.00	0.36	0.00	0.10	0.00	238.00	67.00	0.07	223.00	77.00	0.09
11-May-90	49	15.00	0.3[illegible]		0.11	0.00	238.00	67.00	0.07	222.00	78.00	0.09
14-May-90	52	15.00	0.44		0.13	0.00	238.00	67.00	0.07	220.00	80.00	0.09
16-May-90	54	16.70	0.52		0.14	0.00	238.00	67.00	0.07	219.00	81.00	0.10
18-May-90	56	17.90	0.62		0.16	0.00	238.00	67.00	0.07	218.00	82.00	0.10
21-May-90	59	19.80	0.70		0.17	0.00	238.00	67.00	0.07	215.00	85.00	0.10
22-May-90	60	19.80	0.98		0.32	0.00	236.00	69.00	0.08	208.00	92.00	0.11
24-May-90	62	19.80	1.10		0.34	0.00	235.00	70.00	0.08	207.00	93.00	0.11
29-May-90	67	19.80	1.20		0.37	1.00	234.00	71.00	0.08	207.00	93.00	0.11
30-May-90	68	21.20	1.25		0.39	1.00	eof	eof	eof	206.00	94.00	0.11
04-Jun-90	73	21.70	1.30		0.44	1.00				205.00	95.00	0.11
07-Jun-90	76	22.50	1.45		0.48	2.00				204.00	96.00	0.11
13-Jun-90	82	23.90	1.65		0.58	2.00				203.00	97.00	0.11
18-Jun-90	87	24.80	1.80		0.68	2.00				203.00	97.00	0.11
21-Jun-90	90	24.80	1.90		0.73	2.50				203.00	97.00	0.11
26-Jun-90	95	27.10	2.30	0.00	0.89	3.00				203.00	97.00	0.11
29-Jun-90	98	27.90	2.45		0.97	3.50				202.00	98.00	0.12
02-Jul-90	101	27.90	2.55		1.00	3.50				202.00	98.00	0.12
04-Jul-90	103	28.70	2.65		1.05	3.50				202.00	98.00	0.12
06-Jul-90	105	30.00	2.80		1.15	3.50				202.00	98.00	0.12
10-Jul-90	109	30.00	2.90		1.20	3.50				202.00	98.00	0.12
13-Jul-90	112	30.90	3.00		1.25	3.50				201.00	99.00	0.12
16-Jul-90	115	31.80	3.05		1.30	3.50				201.00	99.00	0.12
19-Jul-90	118	32.70	3.15		1.35	3.50	eof	eof	eof	eof	99.92	0.12
24-Jul-90	123	33.80	3.25		1.40	3.50					102.83	0.12
25-Jul-90	124	33.80	3.35		1.45	3.50					102.83	0.12
31-Jul-90	130	35.70	3.65		1.60	3.80					107.65	0.13
02-Aug-90	132	36.50	3.75		1.65	4.00					109.57	0.13
07-Aug-90	137	36.50	3.95		1.80	4.50					114.07	0.13
13-Aug-90	143	38.80	4.15		1.90	4.80					115.00	0.14
17-Aug-90	147	40.20	4.40		2.15	5.00					116.57	0.14
22-Aug-90	152	40.70	4.55		2.35	5.20					118.59	0.14
27-Aug-90	157	42.70	4.85		2.50	5.50					121.18	0.14
31-Aug-90	161	45.40	5.00		2.61	5.80					124.06	0.15
03-Sep-90	164	45.40	5.15		2.65	6.00					127.25	0.15
07-Sep-90	168	48.70	5.30		2.70	6.30					129.37	0.15
12-Sep-90	173	49.50	5.40		2.81	6.50					131.61	0.15
17-Sep-90	178	50.10	5.45		2.86	6.70					132.92	0.16
21-Sep-90	182	52.10	5.80		2.90	7.00					134.62	0.16
26-Sep-90	187	54.20	6.00		[illegible]	7.00					135.93	0.16

01-Oct-90	192	56.00	eof	eof	3.10	7.20	eof	eof	eof	eof	139.89	0.16
05-Oct-90	196	57.60			3.15	7.30					142.26	0.17
11-Oct-90	202	60.00			3.20	7.40					145.98	0.17
16-Oct-90	207	61.00			3.25	7.50					146.52	0.17
23-Oct-90	214	64.00			3.30	7.80					148.51	0.17
29-Oct-90	220	66.00			3.41	8.00					150.39	0.18
06-Nov-90	228	67.90			3.50	8.30					153.61	0.18
13-Nov-90	235	70.60			3.65	8.50					154.85	0.18
21-Nov-90	243	71.00			4.00	8.60					157.14	0.18
27-Nov-90	249	74.60			eof	8.80					160.12	0.19
05-Dec-90	257	76.40				9.00					161.86	0.19
11-Dec-90	263	78.20				9.50					164.66	0.19
17-Dec-90	269	80.40				9.70					166.34	0.20
21-Dec-90	273	80.40				10.00					168.36	0.20
31-Dec-90	283	81.40	eof	eof	eof	10.00	eof	eof	eof	eof	170.79	0.20
02-Jan-91	285	81.40				10.00					172.85	0.20
08-Jan-91	291	83.30				10.00					174.22	0.20
14-Jan-91	297	86.10				10.10					175.59	0.21
17-Jan-91	300	88.60				10.30					176.59	0.21
23-Jan-91	306	90.40				10.50					177.96	0.21
28-Jan-91	311	92.20				10.50					179.05	0.21
01-Feb-91	315	92.20				10.[illegible]0					180.42	0.21
04-Feb-91	318	94.00				11.00					180.84	0.21
07-Feb-91	321	94.90				11.30					181.94	0.21
12-Feb-91	326	96.60				11.50					182.65	0.21
18-Feb-91	332	96.60				11.60					182.65	0.21
26-Feb-91	340	99.50				11.80					183.75	0.22
01-Mar-91	343	102.30				11.80					184.04	0.22
06-Mar-91	348	105.10	eof	eof	eof	11.80	eof	eof	eof	eof	184.46	0.22
12-Mar-91	354	105.10				11.80					185.85	0.22
18-Mar-91	360	110.00				11.80					185.85	0.22
22-Mar-91	364	111.50				12.00					186.57	0.22
26-Mar-91	368	112.80				12.00					186.57	0.22
01-Apr-91	374	113.50				12.50					187.00	0.22
08-Apr-91	381	117.60				13.50					192.53	0.23
15-Apr-91	388	117.60				13.50					194.80	0.23
22-Apr-91	395	118.70	eof	eof	eof	13.50	eof	eof	eof	eof	193 30	0.23

STATION P4

DATE	DAYS	FACE ADV (m)	VERT MPa MA	STRIKE MP MF	DIP MPA MD	MAX-MIN (N/A)	CL. RIDE NTCM 109	CLOSURE (mm)	STRAIN 840(mm)	CL. RIDE NTCM 110	CLOSURE (mm)	STRAIN 950(mm)
23-Mar-90	0	0.00	0.00	0.00	0.00	0.00	296.00	0.00	0.00	308.00	0.00	0.00
26-Mar-90	3	1.60	0.00	0.00	0.00		289.00	7.00	0.01	301.00	7.00	0.01
27-Mar-90	4	2.50	0.00	0.00	0.00		280.00	16.00	0.02	290.00	16.00	0.02
30-Mar-90	7	4.50	0.00	0.00	0.00		271.00	25.00	0.03	283.00	25.00	0.03
02-Apr-90	10	5.50	0.00	0.00	0.00		268.00	28.00	0.03	279.00	29.00	0.03
05-Apr-90	13	6.80	0.00	0.00	0.00		252.00	44.00	0.05	265.00	43.00	0.05
10-Apr-90	18	7.70	0.00	0.00	0.00		242.00	54.00	0.06	247.00	61.00	0.06
20-Apr-90	28	9.50	0.00	0.00	0.00		233.00	63.00	0.08	238.00	70.00	0.07
25-Apr-90	33	10.00	0.00	0.00	0.00		231.00	65.00	0.08	232.00	76.00	0.08
03-May-90	41	12.60	0.00	0.00	0.00		225.00	71.00	0.08	227.00	81.00	0.09
07-May-90	45	14.30	0.00	0.00	0.05		223.00	73.00	0.09	224.00	84.00	0.09
10-May-90	48	15.00	0.00	0.00	0.06		220.00	76.00	0.09	221.00	87.00	0.09
11-May-90	49	15.00		0.00	0.10		219.00	77.00	0.09	221.00	87.00	0.09
14-May-90	52	15.00		0.00	0.10		219.00	77.00	0.09	221.00	87.00	0.09
16-May-90	54	16.70		0.00	0.11		219.00	77.00	0.09	221.00	87.00	0.09
18-May-90	56	17.90		0.00	0.12		219.00	77.00	0.09	221.00	87.00	0.09
21-May-90	59	19.80		0.00	0.15		219.00	77.00	0.09	221.00	87.00	0.09
22-May-90	60	19.80		0.00	0.31		216.00	80.00	0.10	221.00	87.00	0.09
24-May-90	62	19.80		1.00	0.35		216.00	80.00	0.10	221.00	87.00	0.09
29-May-90	67	19.80		1.00	0.39		216.00	80.00	0.10	221.00	87.00	0.09
30-May-90	68	21.20		1.00	0.41		216.00	80.00	0.10	221.00	87.00	0.09
04-Jun-90	73	21.70		1.50	0.54		eof	eof	eof	eof	eof	eof
07-Jun-90	76	22.50		2.00	0.61							
13-Jun-90	82	23.90		2.00	0.70							
18-Jun-90	87	24.80		2.00	0.85							
21-Jun-90	90	24.80		2.00	0.95							
26-Jun-90	95	27.10	0.00	2.00	1.20							
29-Jun-90	98	27.90		2.50	1.25							
02-Jul-90	101	27.90		2.60	1.40							
04-Jul-90	103	28.70		2.70	1.50							
06-Jul-90	105	30.00		2.85	1.65							
10-Jul-90	109	30.00		3.00	1.70							
13-Jul-90	112	30.90		3.50	1.75							
16-Jul-90	115	31.80		3.60	1.85							
19-Jul-90	118	32.70		3.70	1.95							
24-Jul-90	123	33.80		3.90	2.00							
25-Jul-90	124	33.80		4.00	2.05							
31-Jul-90	130	35.70		4.00	2.20							
02-Aug-90	132	36.50	0.00	4.10	2.35		eof	eof	eof	eof	eof	eof
07-Aug-90	137	36.50		4.20	2.50							
13-Aug-90	143	38.80		4.30	2.60							
17-Aug-90	147	40.20		4.32	2.75							
22-Aug-90	152	40.70		4.35	2.85							
27-Aug-90	157	42.70		4.40	3.00							
31-Aug-90	161	45.40		4.40	3.05							
03-Sep-90	164	45.40		4.50	3.10							
07-Sep-90	168	48.70		4.60	3.15							
12-Sep-90	173	49.50		4.70	3.30							
17-Sep-90	178	50.10		4.90	3.35							
21-Sep-90	182	52.10		5.00	3.45							
26-Sep-90	187	54.20		5.00	3.55		eof	eof	eof	eof	eof	eof

01-Oct-90	192	56.00		5.20	3.65							
05-Oct-90	196	57.60		5.50	3.85							
11-Oct-90	202	60.00		5.70	4.05							
16-Oct-90	207	61.00		5.90	4.20							
23-Oct-90	214	64.00		6.00	4.25							
29-Oct-90	220	66.00	eof	eof	eof	eof	eof	eof	eof	eof	eof	eof
06-Nov-90	228	67.90										
13-Nov-90	235	70.60										
21-Nov-90	243	71.00										
27-Nov-90	249	74.60										
05-Dec-90	257	76.40										
11-Dec-90	263	78.20										
17-Dec-90	269	80.40										
21-Dec-90	273	80.40										
31-Dec-90	283	81.40										
02-Jan-91	285	81.40										
08-Jan-91	291	83.30										
14-Jan-91	297	86.10										
17-Jan-91	300	88.60										
23-Jan-91	306	90.40	eof	eof	eof	eof	eof	eof	eof	eof	eof	eof
28-Jan-91	311	92.20										
01-Feb-91	315	92.20										
04-Feb-91	318	94.00										
07-Feb-91	321	94.90										
12-Feb-91	326	96.60										
18-Feb-91	332	96.60										
26-Feb-91	340	99.50										
01-Mar-91	343	102.30										
06-Mar-91	348	105.10										
12-Mar-91	354	105.10										
18-Mar-91	360	110.00										
22-Mar-91	364	111.50										
26-Mar-91	368	112.80										
01-Apr-91	374	113.50	eof	eof	eof	eof	eof	eof	eof	eof	eof	eof
08-Apr-91	381	117.60										
15-Apr-91	388	117.60										
22-Apr-91	395	118.70	eof	eof	eof	eof	eof	eof	eof	eof	eof	eof

WDL94Q

STATION Q1

DATE	DAYS	FACE ADV (m)	VERT MPa NTSM 250	STRIKE MP NTSM 249	DIP MPa NTSM 239	MAX-MIN NTSM 74	CL. RIDE NTCM 65	CLOSURE (mm)	STRAIN 560(mm)	CL. RIDE NTCM 67	CLOSURE (mm)	STRAIN 530(mm)
27-Apr-90	0	0.00	0.00	0.00	0.00	0.00	320.00	0.00	0.00	299.00	0.00	0.00
02-May-90	5	1.00	0.04	0.00	0.00	0.00	305.00	15.00	0.02	295.00	4.00	0.01
03-May-90	6	1.00	0.09	0.00	0.02	0.00	301.00	19.00	0.03	283.00	16.00	0.02
07-May-90	10	2.10	0.25	0.03	0.09	0.00	290.00	30.00	0.04	252.00	47.00	0.07
08-May-90	11	2.10	0.40	0.05	0.13	0.00	290.00	30.00	0.04	247.00	52.00	0.07
09-May-90	12	3.10	0.49	0.05	0.15	0.00	289.00	31.00	0.05	246.00	53.00	0.08
10-May-90	13	4.10	0.67	0.06	0.19	0.00	287.00	33.00	0.05	241.00	58.00	0.08
11-May-90	14	4.90	0.84	0.07	0.24	0.00	287.00	33.00	0.05	237.00	62.00	0.09
14-May-90	17	4.90	1.00	0.09	0.35	0.00	285.00	35.00	0.05	232.00	67.00	0.10
16-May-90	19	6.20	1.30	0.10	0.45	0.00	280.00	40.00	0.06	228.00	71.00	0.10
17-May-90	20	8.00	1.50	0.13	0.54	0.00	280.00	40.00	0.06	228.00	71.00	0.10
21-May-90	24	8.00	2.10	0.20	0.83	0.00	278.00	42.00	0.06	227.00	72.00	0.10
22-May-90	25	8.80	2.30	0.21	0.91	0.00	277.00	43.00	0.06	220.00	79.00	0.11
24-May-90	27	9.70	2.55	0.25	1.00	0.00	275.00	45.00	0.07	220.00	79.00	0.11
25-May-90	28	10.80	2.70	0.28	1.10	0.00	274.00	46.00	0.07	219.00	80.00	0.11
30-May-90	33	11.50	3.35	0.36	1.25	0.00	273.00	47.00	0.07	218.00	81.00	0.12
04-Jun-90	38	12.50	4.00	0.60	1.70		270.00	50.00	0.07	215.00	84.00	0.12
07-Jun-90	41	15.50	4.45	0.75	2.10		268.00	52.00	0.08	211.00	88.00	0.13
11-Jun-90	45	16.00	6.00	0.85	2.35		267.00	53.00	0.08	210.00	89.00	0.13
14-Jun-90	48	16.90	7.00	1.00	2.60		266.00	54.00	0.08	208.00	91.00	0.13
18-Jun-90	52	17.70	8.00	1.15	3.00		265.00	55.00	0.08	205.00	94.00	0.13
20-Jun-90	54	18.30	8.50	1.25	3.25		265.00	55.00	0.08	204.00	95.00	0.14
22-Jun-90	56	18.30	9.00	1.40	3.45		263.00	57.00	0.08	201.00	98.00	0.14
26-Jun-90	60	19.40	10.00	1.55	3.80		263.00	57.00	0.08	200.00	99.00	0.14
29-Jun-90	63	20.50	10.50	1.85	4.35		263.00	57.00	0.08	198.00	101.00	0.14
03-Jul-90	67	21.60	11.50	1.95	5.50		262.00	58.00	0.09	197.00	102.00	0.15
09-Jul-90	73	23.80	13.00	2.45	7.00		261.00	59.00	0.09	197.00	102.00	0.15
16-Jul-90	80	25.90	14.50	2.80	8.00		260.00	60.00	0.09	197.00	102.00	0.15
23-Jul-90	87	25.90	16.00	3.30	9.00		258.00	62.00	0.09	196.00	103.00	0.15
25-Jul-90	89	25.90	17.00	4.00	10.00		256.00	64.00	0.09	192.00	107.00	0.15
27-Jul-90	91	25.90	17.50	4.15	11.00		255.00	65.00	0.10	190.00	109.00	0.16
01-Aug-90	96	25.90	18.00	4.30	12.00		254.00	66.00	0.10	189.00	110.00	0.16
06-Aug-90	101	25.90	19.00	4.40	12.50		252.00	68.00	0.10	187.00	112.00	0.16
10-Aug-90	105	27.90	19.50	4.60	13.00		250.00	70.00	0.10	184.00	115.00	0.16
16-Aug-90	111	31.10	20.00	4.80	14.00		247.00	73.00	0.11	181.00	118.00	0.17
21-Aug-90	116	34.00	21.00	5.05	14.50		243.00	77.00	0.11	178.00	121.00	0.17
24-Aug-90	119	35.00	21.50	5.10	15.00		240.00	80.00	0.12	176.00	123.00	0.18
28-Aug-90	123	35.00	22.00	5.20	15.00		237.00	83.00	0.12	173.00	126.00	0.18
03-Sep-90	129	35.80	22.50	5.35	16.50		233.00	87.00	0.13	170.00	129.00	0.18
06-Sep-90	132	35.80	23.50	5.60	17.00		233.00	87.00	0.13	170.00	129.00	0.18
10-Sep-90	136	35.80	24.00	5.70	17.30		232.00	88.00	0.13	170.00	129.00	0.18
14-Sep-90	144	36.50	24.50	5.80	17.50		230.00	90.00	0.13	170.00	129.00	0.18
18-Sep-90	147	37.40	26.00	6.00	17.80		228.00	92.00	0.14	170.00	129.00	0.18
21-Sep-90	152	39.30	26.00	6.00	18.00		225.00	95.00	0.14	170.00	129.00	0.18
26-Sep-90	140	40.20	26.50	6.00	18.20		221.00	99.00	0.15	170.00	129.00	0.18

STATION R1

DATE	DAYS	FACE ADV (m)	VERT MPa NTSM 50	STRIKE MP NTSM 97	DIP MPa NTSM 95	MAX-MIN NTSM 71	CL. RIDE Omega 10	CLOSURE (mm)	STRAIN 680mm	CL. RIDE NTCM 102	CLOSURE (mm)	STRAIN 700(mm)
21-May-90	0	0.00	0.00	0.00	0.00	0.00	300.00	0.00	0.00	290.00	0.00	0.00
22-May-90	1	0.00	0.00	0.00	0.00	0.00	276.00	24.00	0.04	165.00	125.00	0.18
24-May-90	3	0.00	0.00	0.00	0.00	0.00	275.00	25.00	0.04	165.00	125.00	0.18
28-May-90	7	1.30	0.00	0.00	0.00	0.00	273.00	27.00	0.04	165.00	125.00	0.18
30-May-90	9	1.30	0.00	0.00	0.00	0.00	270.00	30.00	0.04	165.00	125.00	0.18
04-Jun-90	14	1.30	0.00	0.00	0.00	0.00	270.00	30.00	0.04	163.00	127.00	0.18
07-Jun-90	17	3.10	0.00	0.00	0.00	0.00	269.00	31.00	0.05	162.00	128.00	0.18
13-Jun-90	23	3.70	0.04	0.00	0.00	0.00	268.00	32.00	0.05	160.00	130.00	0.19
18-Jun-90	28	4.60	0.07	0.01	0.00	0.00	268.00	32.00	0.05	159.00	131.00	0.19
21-Jun-90	31	6.10	0.10	0.02	0.00	0.00	267.00	33.00	0.05	158.00	132.00	0.19
26-Jun-90	36	8.20	0.15	0.02	0.00	0.00	266.00	34.00	0.05	158.00	132.00	0.19
29-Jun-90	39	8.20	0.27	0.05	0.00	0.00	266.00	34.00	0.05	157.00	133.00	0.19
02-Jul-90	42	9.00	0.37	0.18	0.00	0.00	266.00	34.00	0.05	156.00	134.00	0.19
04-Jul-90	44	9.00	0.50	0.42	0.00	0.00	266.00	34.00	0.05	156.00	134.00	0.19
06-Jul-90	46	9.00	0.74	0.51	0.00	0.00	266.00	34.00	0.05	156.00	134.00	0.19
10-Jul-90	50	10.20	0.92	0.74	0.05	0.00	260.00	40.00	0.06	156.00	134.00	0.19
13-Jul-90	53	10.20	1.06	0.83	0.08	0.00	258.00	42.00	0.06	156.00	134.00	0.19
16-Jul-90	56	11.00	1.15	0.95	0.10	1.00	256.00	44.00	0.06	156.00	134.00	0.19
19-Jul-90	59	12.00	1.30	1.00	0.14	1.20	254.00	46.00	0.07	156.00	134.00	0.19
24-Jul-90	64	13.50	1.62	1.00	0.25	1.30	250.00	50.00	0.07	156.00	134.00	0.19
25-Jul-90	65	13.50	1.85	1.50	0.40	1.40	249.00	51.00	0.08	156.00	134.00	0.19
31-Jul-90	71	15.50	2.00	2.00	0.80	1.85	245.00	55.00	0.08	156.00	134.00	0.19
02-Aug-90	73	16.30	2.20	2.50	1.00	2.00	243.00	57.00	0.08	156.00	134.00	0.19
08-Aug-90	79	19.50	2.40	3.00	1.30	2.30	240.00	60.00	0.09	156.00	134.00	0.19
13-Aug-90	84	20.40	2.60	3.50	1.50	2.60	236.00	64.00	0.09	156.00	134.00	0.19
20-Aug-90	91	22.00	2.95	3.80	1.95	2.90	233.00	67.00	0.10	156.00	134.00	0.19
24-Aug-90	95	25.30	3.40	4.00	1.40	3.10	23[illegible].00	68.00	0.10	156.00	134.00	0.19
28-Aug-90	99	27.50	3.60	4.10	1.70	3.50	23[illegible]	69.00	0.10	156.00	134.00	0.19
31-Aug-90	102	28.00	3.85	4.20	2.05	3.90	230.00	70.00	0.10	156.00	134.00	0.19
03-Sep-90	105	29.10	4.00	4.50	2.25	4.00	227.00	73.00	0.11	156.00	134.00	0.19
07-Sep-90	109	32.10	4.25	4.60	2.35	4.30	222.00	78.00	0.11	156.00	134.00	0.19
10-Sep-90	112	33.10	4.40	4.80	2.50	4.45	218.00	82.00	0.12	156.00	134.00	0.19
13-Sep-90	115	33.60	4.65	5.00	2.52	4.70	217.00	83.00	0.12	156.00	134.00	0.19
17-Sep-90	119	34.70	4.80	5.20	2.55	4.85	216.00	84.00	0.12	156.00	134.00	0.19
20-Sep-90	122	35.10	4.95	5.40	2.60	5.05	214.00	86.00	0.13	156.00	134.00	0.19
24-Sep-90	126	37.50	5.00	5.50	2.70	5.25	213.00	87.00	0.13	156.00	134.00	0.19
26-Sep-90	128	38.10	5.30	5.80	2.80	5.30	212.00	88.00	0.13	156.00	134.00	0.19
01-Oct-90	133	38.90	5.50	eof	2.90	5.90	209.00	91.00	0.13	156.00	134.00	0.19
05-Oct-90	137	40.30	5.70		3.00	6.00	208.00	92.00	0.14	156.00	134.00	0.19
11-Oct-90	143	44.20	5.90		3.10	eof	207.00	93.00	0.14	156.00	134.00	0.19
16-Oct-90	148	45.00	6.10		3.30		205.00	95.00	0.14	156.00	134.00	0.19
23-Oct-90	155	47.10	6.40		3.50		204.00	96.00	0.14	156.00	134.00	0.19
29-Oct-90	161	48.30	6.50		3.70		201.00	99.00	0.15	156.00	134.00	0.19
31-Oct-90	163	49.30	6.70		3.80		200.00	100.00	0.15	156.00	134.00	0.19
02-Nov-90	165	50.00	7.00		4.00		199.00	101.00	0.15	156.00	134.00	0.19
06-Nov-90	169	50.00	7.20		4.10		198.00	102.00	0.15	156.00	134.00	0.19
09-Nov-90	172	52.40	7.40		4.30		197.00	103.00	0.15	156.00	134.00	0.19
13-Nov-90	176	53.00	7.50		4.50		195.00	105.00	0.15	156.00	134.00	0.19
21-Nov-90	184	54.00	7.60	eof	eof	eof	192.00	108.00	0.16	eof	eof	eof
27-Nov-90	190	56.20	7.70				190.00	110.00	0.16			
05-Dec-90	198	58.20	7.90				189.00	111.00	0.16			

11-Dec-90	204	61.70	8.00				188.00	112.00	0.16			
17-Dec-90	210	61.70	8.20				187.00	113.00	0.17			
21-Dec-90	214	62.60	8.30				187.00	113.00	0.17			
31-Dec-90	224	62.60	8.80				186.00	114.00	0.17			
02-Jan-91	226	65.20	9.00				186.00	114.00	0.17			
08-Jan-91	232	67.10	9.30				185.00	115.00	0.17			
14-Jan-91	238	67.50	9.50				185.00	115.00	0.17			
17-Jan-91	241	67.50	9.60				184.00	116.00	0.17			
23-Jan-91	247	69.20	9.80				184.00	116.00	0.17			
28-Jan-91	252	71.10	10.00				184.00	116.00	0.17			
01-Feb-91	256	71.10	10.00	eof	eof	eof	182.00	118.00	0.17	eof	eof	eof
07-Feb-91	262	73.00	10.50				181.00	119.00	0.18			
12-Feb-91	267	74.90	11.00				179.00	121.00	0.18			
20-Feb-91	275	75.70	11.50				178.00	122.00	0.18			
26-Feb-91	281	79.10	12.00				177.00	123.00	0.18			
07-Mar-91	290	82.90	12.20				176.00	124.00	0.18			
11-Mar-91	294	84.60	12.30				175.00	125.00	0.18			
18-Mar-91	301	86.70	12.50				174.00	126.00	0.19			
28-Mar-91	311	88.30	13.00				174.00	126.00	0.19			
02-Apr-91	316	91.40	13.50				173.00	127.00	0.19			
08-Apr-91	322	95.00	13.80				172.00	128.00	0.19			
26-Apr-91	340	100.80	14.00				170.00	130.00	0.19			

APPENDIX B

1) INPUT PARAMETERS FOR MINSIM-D MODEL

Young's Modulus - 70 GPa
Poisson's ratio - 0,2
Grid size - 10 m
Depth - 2700 m
Stoping width - 1 m

Backfill parameters

Cohesion - 0
Friction angle - 30°
Backfill type - Hyperbolic
a parameter - 10 MPa
b parameter - 0,30

2) INPUT FILE FOR FLAC RUN - Simulation of in situ, inclined backfill rib

```
grid 100 100
gen 0 0 0 50 50 50 50 0
fix x i=1, i= 101
fix y j=1
app pressure= - 52 MPa j=101
int sxx=26e6 syy=52e6
Prop Density=2700 Bulk=1e8 Shear=0.3e8 **rock**
Prop Density=1000-2000 Bulk=1e7 Shear=0.3e7
**backfill**
```

3) INPUT FILE FOR FLAC RUN - Simulation of laboratory test

Elastic backfill (Interface - Slip and separation)

```
grid 30 11
m e i=1,10 j=1,3
prop dens=3000 bulk=3e8 shear=0.3e8 i=1,10 j=1,3
m e i=1,10 j=9,11
prop dens=3000 bulk=3e8 shear=0.3e8 i=1,10 j=9,11
m e i=1,30 j=5,7 prop dens=1000 bulk=3e6 shear=0.3e6
i=1,30 j=5,7
m null i=1,3 j=5 7
m null i=28,30 j=5,7
m null  j=4
m null  j=8
gen 0,0 0,4.3 10,4.3 10,0  i=1,11 j=1,4
gen 0,4.3 0,5.3 10,5.3 10,4.3  i=1,31 j=5,8
gen 0,5.3 0,10 10,10 10,5.3 i=1,11 j=9,12
int 1 Aside from 1,4 to 11,4 Bside from 4,5 to 28,5
int 1 kn 2e10 ks 2e10 fric=15
int 2 Aside from 4,8 to 28,8 Bside from 1,9 to 11,9
int 2 kn 2e10 ks 2e10 fric=15
fix x i=1
fix x i=31 j=5,8
fix x i=11 j=1,4
fix x i=11 j=9,12
fix y j=1
app press=1e6 i=1,11 j=12
```

4)INPUT FILE FOR FLAC RUN - Simulation of laboratory test

Mohr-Coulomb Backfill (Interface - Slip and separation)

```
grid 30 11
m e i=1,10 j=1,3
prop dens=3000 bulk=3e8 shear=0.3e8 i=1,10 j=1,3
m e i=1,10 j=9,11
prop dens=3000 bulk=3e8 shear=0.3e8 i=1,10 j=9,11
```

```
m m i=1,30 j=5,7
prop dens=1000 bulk=3e6 shear=0.3e6 fr=33 dil=12
ten=1e10 co=1e4 i=1,30 j=5,7
m null i=1,3 j=5,7
m null i=28,30 j=5,7
m null  j=4
m null  j=8
gen 0,0 0,4.3 10,4.3 10,0  i=1,11 j=1,4
gen 0,4.3 0,5.3 10,5.3 10,4.3  i=1,31 j=5,8
gen 0,5.3 0,10 10,10 10,5.3 i=1,11 j=9,12
int 1 Aside from 1,4 to 11,4 Bside from 4,5 to 28,5
int 1 kn 2e10 ks 2e10 fric=15
int 2 Aside from 4,8 to 28,8 Bside from 1,9 to 11,9
int 2 kn 2e10 ks 2e10 fric=15
fix x i=1
fix x i=31 j=5,8
fix x i=11 j=1,4
fix x i=11 j=9,12
fix y j=1
app press=1e6 i=1,11 j=12
```