As a general rule sulphides and other metallic minerals are more abundant in the wall rocks than in the fracture fillings themselves.

It is evident from the above description that arsenopyrite, gold, chalcopyrite and second generation pyrite, in approximately that order, are of more or less contemporaneous or overlapping origin, and all are considerably later than pyrite of the first generation. The mode of occurrence of the second generation pyrite suggests that its origin has taken place at a considerably lower temperature than that of the first generation type. Remarks on the factors controlling the distribution of gold have already been made, but it must be borne in mind that the movement which has taken place on the plane of the mineralised fractures during the hydrothermal sequence is not the only factor controlling deposition of the later minerals. Fracture branches and intersections are the primary localising influences, since in their vicinity the effective permeability of the passages was generally maintained until the last stages of hydrothermal activity.

The effect of impregnation and replacement of the wall rocks is the same, whether the fracture has a filling or not. The mechanism whereby solutions travel along a fracture plane, impregnating the wall rocks on either side without depositing anything in the passage itself, is not clear. It would seem, however, that where the fracture has given rise to a narrow, intensely sheared and crushed zone, the material within this zone has been more or less completely replaced, resulting in a massive quartz filling. In those cases where the fracture has taken the form of a more or less clean break with some shattering of the walls, but without giving rise to a definite sheared zone, no filling has been formed, and the wall rocks have been more or less impregnated, while the shattered or brecciated zone has been the site of the deposition of a reticulated system of thin quartz veinlets between the breccia blocks. In the fracture walls in such cases, the rock commonly consists of a series of angular blocks of the country rock, cemented by a mesh of thin quartz veinlets which often contain sulphides. At the same time these breccia blocks have been more or less altered and impregnated by quartz, sericite, sulphides, etc. Similar phenomena are, of course, also found in the vicinity of fractures which carry the so-called filling. Within a short distance of the fracture these brecciation phenomena disappear, but the effects of impregnation are usually visible much farther into the walls. Finally, of course, all signs of impregnation and replacement also die out.

As a general rule, the rock in the fracture walls is a pale to dark green material, cut by numerous quartz veinlets, and containing scattered pyrite grains, crystals, etc. The presence of the quartz veinlets, a larger amount of sulphides, and a slightly darker colour, are the only features by which the mineralised rock differs from the unmineralised green "schist" as already described.

Fresh quartz, that is, quartz introduced during the mineralisation, occurs as veinlets and irregular masses in the ore, and generally shows only slight evidence of strain. This quartz contains many minute liquid inclusions and flakes of sericite. The latter mineral is, in general, very plentiful in the ores as masses interstitial to the quartz grains, impregnating the whole rock, and sometimes intimately associated with pyrite masses. It usually occurs together with small flakes of talc and aggregates of green chlorite.

Talc occurs mainly as tiny flakes associated with abundant green chlorite in veinlets and masses often surrounding and associated with masses of second generation pyrite. Talc and chlorite, together with rutile, are most plentiful in the ore when the original rock was the soft, dark, vivid green type.

The peculiar, very pale chloritic mineral is often found as irregular grains and sometimes as aggregates sporadically distributed throughout the ore.

Calcite and dolomite occur more or less abundantly as isolated crystals, irregular aggregates, and in the form of veinlets, which often also contain green chlorite and have narrow talc selvedges.

Tiny isolated needles and nests of a very pale green-brown pleochroic tourmaline are often found associated with crystals of first generation pyrite.

The occurrence of pyrite, arsenopyrite, chalcopyrite and gold is exactly similar to that already described in connection with the fillings, except that the proportion of these metallic minerals in the fracture walls is usually somewhat higher than is the case in the fillings.

In some instances, where the alteration and impregnation processes have been abnormally intense, the proportion of metallic minerals present is high, and the development of sericite, chlorite and talc has progressed to such a point that the original texture of the rock has been almost completely obliterated, and it has taken on a very dark green, almost black, colour.

When the fractures enter the gray "schist" they assume entirely different characteristics, owing partly to different chemical conditions, and partly to the fact that the gray "schist" slides, shears and folds, and does not bracciate. There is usually intense minute internal folding near the fracture plane, and the effects of the hydrothermal solutions die out completely some 10 to 12 inches from the fracture, as contrasted with a distance of 5 to 15 feet in the case of the green "schist". Such conditions are especially clearly shown in the area where the green-gray "schist" contact is displaced by a fracture. The later stages of mineralization appear to have had practically no effect on, and apparently hardly penetrated at all into, the gray "schist".

The fractures in the gray "schist" often have what appears to be a true filling, but this is usually only ½ inch to 1 inch in thickness. This filling, which is usually white, consists mainly of a mosaic of quartz, calcite and dolomite, none of which shows much sign of strain. Thin veinlets of clear vitreous and white quartz and carbonates are very common for a few inches from the main fracture, to which they are usually more or less parallel. These probably occupy glide or shear planes, sympathetic to the main plane of movement.

The gray "schist" on either side is generally sericitised to some extent for a distance of 3 or 4 inches from the fracture, and in this zone are also found small aggregates of zeolites and the peculiar colourless chloritic mineral. This latter mineral in the form of a more or less massive aggregate forms a selvedge some ¼ to ½ inch thick, on either side of the main fracture. The white quartz and carbonate filling usually contains minute needles of pale tourmaline and tiny flakes of green talc, as well as a few small scattered grains of first generation pyrite. Second generation pyrite and the other metallic minerals usually associated with it are almost completely absent. Crystals of first generation pyrite occur scattered in the gray "schist" up to 12 inches or so from the fracture, and are sometimes quite abundant along the outside boundaries of the filling.

The Birthday ores have been formed by general impregnation and replacement of intensely fractured and strained zones. This is contrasted with the Zwartkopje ores, which have been formed in and along the walls of definite, persistent and more or less simple fractures. This difference in mode of formation, together, probably, with other differences in general conditions, has resulted not only in a different type of deposition, but also, of course, in ore bodies unlike those in the Zwartkopje area in shape, size, and mode of occurrence. Though, as has already been mentioned, the fractured zone is usually near the green-gray "schist" contact, and some of the fractures actually pass into the gray "schist", the impregnation due to the passage of hydrothermal solutions stops at the contact, and no ore is found in the latter rock. As is to be expected from its mode of origin, the ore is generally traversed in all directions by innumerable small veinlets of quartz and carbonates. These occupy the minutely intricate system of cracks brought about by the intense fracturing. A good proportion of the introduced minerals probably replaced the original rock material by reason of the fact that the latter was under the influence of considerable unrelieved strain. At least, this feature facilitated the replacement processes which were of overwhelming importance in the development of these ore bodies.

The ores generally are pale to dark green, and can be readily seen to be merely altered green "schist" of various types. The development of considerable amounts of green chlorite and the formation of vast numbers of veinlets, from 1mm. to 1cm. in thickness, of quartz and carbonates, together with the introduction of considerable amounts of quartz and sulphides has affected the appearance of the rock to an appreciable degree. Many of the veinlets are more or less cellular, on account of the fact that the surface waters which percolate down the highly fractured zones have oxidised and leached out some of the sulphides, leaving behind quantities of red and brown ferruginous mud, which is almost always present in the Birthday ores, down to the depths reached so far. The ore is often more or less schistose, a structure inherited from the original green "schist". In some cases replacement by quartz and carbonates with the sulphides, etc., together with a certain degree of recrystallisation, has completely altered the constitution of the rock, which has become massive and granular. The chlorite left in the intergranular areas and associated with the sulphides imparts a dull green colour to the mass.

The ore consists mainly of an intensely strained quartz mosaic with a fair amount of mortar composed chiefly of sericite and quartz. The mortar is probably partly original in the rock, and partly due to the pre-mineral fracturing. The quartz usually contains a vast number of minute inclusions, chiefly liquids, sericite flakes, and minute needles of a pale tourmaline. The quartz introduced by the hydrothermal processes is not so intensely strained as it is in many of the fillings in the Zwartkopje fractures. This is due to the fact that the rocks in the Birthday area have been less affected by movement during mineralisation.

Sericite, chlorite, carbonates, rutile, talc, magnetite, etc., occur in the same manner as they do in the Zwartkopje ores. The carbonates in the veinlets in the Birthday ores sometimes have a peculiar pale mauve colour. Tourmaline of a very pale green-brown type is far more widespread in these than in the ores previously described; in fact, almost solid, felted masses of needles of this mineral are not uncommon.

Hematite and other iron oxides formed by the action of meteoric waters are frequently encountered in sections cut from the Birthday ores.

Occasional scattered crystals, averaging ½mm. in diameter, of pyrite of the first generation are found disseminated in the Birthday ores, both in the impregnated material and in the quartz veinlets, many of them with fibrous or bladed quartz borders. These occurrences are, however, something of a rarity. More common, but still not by any means abundant, are skeletal grains, small aggregates, and shells of pyrite of the second generation. These occasionally enclose crystals of first generation pyrite, and sometimes contain gold in the form of tiny irregular grains. This sulphide is in general not plentiful in the Birthday ores, and is very seldom found in large masses such as those found in the Zwartkopje area. Second generation pyrite is occasionally found moulded on arsenopyrite needles. Pyrite grains in general are quite often surrounded by a border of iron oxide minerals.

Arsenopyrite is by far the most common sulphide in the Birthday ores. It occurs almost always as needles ranging in length from 0·1mm. to 1·5mm., but with average dimensions of about 0.05mm. x 0.5mm. These needles are found isolated, in clusters and groups, and sometimes in solid felted masses; most of them occur associated with tourmaline along the edges of quartz veinlets, and when they are very abundant, they often enclose or are associated with small irregular grains of stibnite. Many of the arsenopyrite needles are cut in all directions by thin veinlets of hydrated iron oxides, while some are hollow or skeletal.

Irregular particles of gold ranging in size from 3μ to 25μ occur enclosed in arsenopyrite needles, and, though rarely, enclosed in the gangue minerals away from sulphides.

Very small quantities of chalcopyrite are present, usually intimately associated with arsenopyrite and second generation pyrite.

Stibnite is sometimes found enclosed in or occurring with arsenopyrite crystals, but is not associated with pyrite of either the first or second generation types. The antimony sulphide is much more common in the Birthday than in the Zwartkopje ores, and this may be due to its having some genetic relationship to the arsenopyrite. Such a relationship is not unknown in gold deposits in rocks of the Primitive System. Stibnite sometimes occurs as coarsely crystalline masses up to 10cm. in diameter, and in very heavily mineralised areas is found with ankerite lining vugs. The masses of stibnite can sometimes be seen to be moulded on arsenopyrite; they are thus partly contemporaneous with and partly later than the latter.

In the ores described it is evident that gold and the minerals associated and more or less contemporaneous with it were deposited at a late stage, under conditions of relatively low temperature and pressure. This accounts for the fact that these minerals are found only where fairly easy solution passages existed. Such features as the formation of shells and coatings by pyrite and arsenopyrite, and the occurrence of stibnite in open spaces, indicate deposition at comparatively low temperatures and pressures.

Hall states, with regard to the Zwartkopje fractures, "These are sharply defined, and appear as very thin lines of discontinuity without fault breccias or other results of movement."[1] Actually, a great deal of brecciation and fracturing have taken place in the rocks adjacent to the fractures, and in many cases a band of crushed and sheared rock forms the fracture zone. At the same time almost all the fractures have definite displacements on the country rocks. Hall mentions stoping widths up to 50 feet on the Zwartkopje fractures,[2] this is the case

[1] Geological Survey Memoir No. 9, p. 256.

[2] Ibid., p. 257.

only in the vicinity of splits and intersections, where fracturing and brecciation are abnormally severe.

No description of the Birthday ores has been given in any previous literature.

Photomicrographs on Plates XLIII-XLV are of specimens of the green "schist" ores.

(2) In The Shales

General

General remarks on the ore bodies in the shales have already been made, and their occurrence at different places described. The ores themselves all show the same characteristics, whether they be from the Intombi, Insimbi, Southern Cross, or other fractures. It is interesting, in the case of a fracture which passes from green "schist" to shale, to follow the change in the appearance of the ores and the nature of the mineralisation. It seems probable that the change in chemical and physical nature of the fracture walls, and in the nature of the fracture itself, is responsible for the difference in type of mineralisation.

Shale fractures, whether barren or not, almost always have a well defined filling, which has abrupt contacts with the wall rocks; that is, the filling has originated rather by occupation of a more or less open space or fractured zone than by replacement of sheared and brecciated rock in the vicinity of a break, as is generally the case in the green "schist". The filling may be as little as ¼ inch, or as much as 12 inches in thickness, and may consist of a more or less solid mass of introduced minerals; or, it may include lenses, sheets and fragments of altered and sheared shale, evidently remnants of the sheared material in the fracture zone.

Petrography of the Ores

In the case of barren fractures, the filling is generally a solid mass of intricately interlocking crystals of carbonates, mainly dolomite. The carbonate crystals are usually more or less elongated perpendicular to the vein, and have a white or light gray colour. These carbonates do not replace or react with the walls to any significant extent, and so constitute what may be called a true vein filling.

The wall rocks on either side always show evidence of shear. In thin section the shale within some 24 inches of the vein consists of the usual quartz and chert grains, elongated and more or less deformed by the shearing consequent upon the fracturing. Shear planes are usually very numerous, and impart to the rock a schistose appearance in thin section. These glide or shear planes frequently contain graphite, and in their vicinity there are almost always masses of sericite, chlorite, talc, and a little colourless mica. Graphite can almost invariably be found as thin films on the contacts of filling and walls, and in the vicinity of sheets of sheared shale enclosed in the vein material.

On fracture surfaces, which are generally shear planes parallel to the fracture, hand specimens of shale near the veins often show small lumps, knots or spots of an average diameter about 0·25mm. Microscopic examination proves these spots to be tiny irregular masses of optically continuons dolomitic carbonate. They are evidently the early stage in the formation of crystals at separated points, in a mass of rock impregnated more or less by solutions rich in carbonates. The spots evidently grow by replacement of and "forcing aside" the surrounding rock, since the shear planes in their vicinity are bent out around them in a manner similar to that found in the vicinity of metacrysts forming in a foliated metamorphic rock.

Sulphides are not common in and in the vicinity of the barren fractures. The only metallic mineral present in most cases is pyrite, in the form of well developed crystals from 0·25mm. to 1mm. in mean diameter. The commonest crystal form is a combination of the cube and pyritohedron. This kind of occurrence is typical of the first generation pyrite. The crystals occur either singly or in groups or loose aggregates, and may be found within the carbonate filling, in the wall rocks, and more commonly along the outer borders of the filling. In the filling and in the wall rocks the commonest mode of occurrence is that of single isolated crystals, while the loose aggregates are generally found along the edges of the vein.

Masses of sericite, chlorite and talc are almost invariably found in association with the pyrite, which, in the wall rocks, often has a narrow border of the usual fibrous or bladed quartz. The distribution of pyrite and other metallic minerals in the shale veins, barren or otherwise, is apparently independent of the occurrence of graphite, and the occasional association of the metallic minerals and carbon is probably purely accidental.

Mention has already been made of the occurrence of white quartz, together with other metallic minerals including gold, in some places on the shale fractures, and a description of their distribution and the factors controlling it have been given. Wherever gold values are recorded on shale fractures, white quartz, together with fairly abundant pyrite and "needlepoint" arsenopyrite, is almost certainly to be found. The converse, however, does not always hold good. Arsenopyrite in the form of tiny needles, the so-called "needlepoint arsenic", is generally accepted as an indicator of the presence of gold in fair quantities. This is based on sound principles, since arsenopyrite is most commonly deposited as a dissemination in the wall rocks, and this can take place to a significant extent only when these rocks have been abnormally severely strained and sheared, as is the case in the vicinity of fracture intersections, etc.

The fractures which are associated with mineralisation of economic importance generally show well developed comb structure or crustification in the filling. The outer part, that is, along the walls, consists of the gray carbonates, while the inner part is made up of a white quartz mosaic. Sketches illustrating the structure of these veins have been given (Fig. 6, page 255). White quartz also occurs as irregular masses and veinlets in the shale walls, and is frequently associated with sulphides.

The middle or quartz part of the filling generally consists of a mosaic of more or less unstrained quartz with masses and veinlets of sericite, chlorite, talc, etc. Occasionally the quartz in the filling shows evidence of movement having occurred during deposition, that is, various strain and crush phenomena are exhibited. In a few cases strain and shear during deposition have resulted in a peculiar structure in which the orientation of successive layers in a quartz grain is slightly different. Slickensided surfaces are occasionally to be found in the quartz filling. Examination of thin sections of such areas shows that this phenomenon is due to replacement by the quartz of sheared material previously existing in the fracture zone, and not to movement during the latter stages of deposition, since no strain or crush phenomena are visible in the vicinity of the slickensided surfaces. Actually, the quartz grains in the mosaic merely show irregular lines of discontinuity on these surfaces.

Masses of pyrite of the second generation type are often found in the quartz filling. These usually take the form of loose aggregates of irregular, skeletal and zoned grains, which sometimes contain minute (5-10μ) particles of gold, and are usually intimately associated with masses of sericite, talc and chlorite, the latter often of the penninite variety. The pyrite grains and masses sometimes have narrow borders of fibrous or bladed quartz, and occur irregularly distributed throughout the quartz filling, but show a tendency to concentrate in the vicinity of the quartz-carbonate contact zone. Other sulphides such as arsenopyrite and chalcopyrite are very rare in the filling, though the latter is sometimes found enclosed by and associated with the second generation pyrite. Crystals of pyrite of the first generation are very sparsely distributed.

The outer or carbonate part of the filling is similar in nature to that found in the barren veins. It consists of a mosaic made up of interlocking grains of dolomite and calcite, chiefly the former. The carbonates are cut in all directions by thin veinlets of quartz from the inner part of the filling. The contact of the carbonates with the walls is invariably sharp, and is often marked by thin films of graphite.

Metallic minerals are very rare in the carbonate parts of the veins, and the only one which is found is pyrite of the first generation, occurring as small, well formed crystals. Along the vein walls, that is, at the contact of the carbonates and the walls, masses, loose aggregates, and isolated grains of pyrite of both types are found, sometimes with a little finely divided gold in that of the second generation. The masses and aggregates may be as large as ½ inch by 2 inches, but are usually much smaller, and frequently consist of composite grains of the two types. Masses of sericite, talc, and chlorite, and occasionally tiny needles of tourmaline, occur in association with the sulphides.

The shale walls of veins associated with economically valuable mineralisation exhibit the same general characteristics as do those of barren veins; that is, the rock is so sheared as to possess an incipient schistosity parallel to the fracture; the matrix is very fine, and consists of sericite, quartz and chlorite; the original particles of quartz and chert are flattened and elongated; and the shear planes frequently contain films of graphite.

Later, hydrothermal quartz and carbonates occur as thin veinlets and as scattered irregular grains and masses, replacing the original rock. These introduced minerals show only very weak strain phenomena. In some places, where mineralisation has been very intense, later quartz has almost completely replaced parts of the wall rock. The veinlets of quartz which cut the wall rock usually contain masses and aggregates of sericite, chlorite and talc. The "spots" formed by dolomite in some places near the barren veins are also often found in the vicinity of mineralised areas. In the latter case these "spots" are often cut by thin veinlets of quartz and have tiny nuclei of the same mineral.

Pyrite of both types occurs in the wall rocks, but the second generation type is far more abundant than the other. The first generation type usually occurs as scattered, small and well formed crystals, sometimes associated with a little pale green-brown tourmaline, and almost always accompanied by chlorite and sericite. Pyrite of the second generation is widespread, and occurs as isolated irregular grains, both solid and skeletal, and as loose masses and aggregates. In these aggregates many of the component particles are composite grains with a crystal of first generation pyrite as core. The composite grains frequently have an intermediate zone of gangue, which is sometimes continuous and sometimes broken. Generally the pyrite aggregates are irregularly distributed, but sometimes they occur as lenticles arranged in the shear planes in the shale. The lenticles in any one shear plane are generally connected by a veinlet of quartz with sericite, chlorite and talc. Aggregates and masses of pyrite are almost invariably cut by irregular veinlets of quartz. The second generation pyrite is almost always associated with later quartz, sericite and chlorite; it replaces the original minerals in the wall rocks, and frequently has a narrow border of fibrous or bladed quartz. When separate masses or grains of this pyrite occur within about 0.2mm. of one another, the intervening space is often taken up by this bladed quartz, which has its elongation perpendicular to the pyrite boundaries. The aggregates of fine grained pyrite of the second generation may exceptionally reach dimensions of ½ inch by 3 inches, but are more usually about ¼ inch x ½ inch. Second generation pyrite is sometimes found moulded on crystals of arsenopyrite.

Arsenopyrite is frequently found in the wall rocks in mineralised fractures, and is roughly proportional in amount to the intensity of the mineralisation. This mineral almost invariably occurs in the form of well developed needles of average size about 0·1 x 0·5mm., but often larger. The needles are frequently skeletal, having a core of quartz or mixed quartz, sericite and chlorite. For the most part, arsenopyrite needles occur scattered throughout the rock, but they are often found as loose aggregates and felted masses, frequently associated with thin quartz veinlets. Crystals of this mineral are occasionally moulded on crystals of pyrite of the first generation.

Chalcopyrite is very rare, and usually occurs in the form of minute irregular blebs associated with and enclosed in pyrite of the second generation. Pyrrhotite is only very seldom seen, and occurs as minute irregular blebs in the gangue, and associated with first generation pyrite.

Gold is seldom seen in polished sections of the shale ores, and that which has been seen is in the form of minute (5-15μ) irregular grains, enclosed in second generation pyrite. None has been seen associated with arsenopyrite. Coarse gold is exceedingly rare in the shale ores, and is practically never visible in hand specimen.

No direct relation between the sulphides and graphite has been seen in the shale ores.

The ores associated with fractures in the shales contain a considerable amount of sulphide, both pyrite and arsenopyrite, in the form of irregular particles below 20μ in average diameter.

The effects on the walls of the passage of hydrothermal solutions along fractures in the shales gradually die out, and become finally indiscernable some 3 to 4 feet from the fracture plane or zone. The distance to which mineralisation of economic value extends from the fracture into the walls varies, of course, within wide limits from point to point, and from one fracture to another.

The crustification of carbonates and quartz, the mode of deposition of pyrite of the second generation, and the occurrence of pyrite lenticles in shear planes in the fracture walls all point to the same conclusion as that reached from a study of the other ores on the property, viz., that the later, major and economically important deposition took place at relatively low temperatures and pressures.

Photomicrographs on Plate XLVI are of specimens of the shale ores.

(3) In The Bars

General

The bars as a general rule do not make good host rocks for hydrothermal mineralisation, since the chert is very fine grained, massive, with little cleavage, etc., and of more or less uniform composition. The result is that dissemination of hydrothermal minerals in the bar material itself is rare.

The bars are mineralised only in the very near vicinity of fractures, e.g., where a fracture passes through or follows the chert horizon. As a general rule, however, mineralisation effects are not noticeable in the chert more than 2 feet or so from the fractures, and in many cases these effects die out a matter of inches from the break.

The commonest cases of mineralisation of the bars occur in the Zwartkopje area, where the fractures cut and displace, or turn down into or under the Zwartkopje Bar. The Southern Cross Bar is also mineralised to a small extent in the vicinity of its line of intersection with the Insimbi Fracture.

Gold values in the chert bars are generally not high, but in isolated cases where two or more fractures intersect in the bar, the brecciation is very intense, mineralisation has consequently been heavy, and gold values are high.

Fractures in the chert horizons are generally clean-cut breaks, either with no filling at all, or with a vein of quartz at most some ½ inch thick. The chert on either side of the main fracture, however, has been shattered into angular fragments of all shapes and sizes. This shattering has allowed the penetration of quartz and other vein minerals into the walls, which are consequently made up of small angular chert fragments cemented by thin veinlets of colourless vitreous quartz and other subordinate minerals. The result is what Norton[1] calls a "crackle breccia." The veinlets, reticulating in all directions, can almost always be easily seen in hand specimen, owing to the vitreous nature of their filling as contrasted with the dull black chert in the breccia fragments. The

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[1] W.H. Norton, Journal of Geology, xxv, 1917, p. 161.

veinlets are from ½mm. to 5mm. in thickness.

Such sulphides as occur in these ores are found almost entirely in the veinlets, that is of course, with the exception of those which sometimes occur also in the unmineralised bars. Dissemination of vein minerals into the breccia fragments and unbrecciated bar is practically negligible.

Petrography of the Ores

These ores are very simple, on account of the lack of impregnation, dissemination, and alteration effects on the breccia fragments and country rock in general.

The fracture fillings consist mainly of a more or less crushed and strained quartz mosaic, cut by later veinlets of the same mineral. The mosaic is evidently the earlier filling which has in many cases been affected by movement on the fracture during the latter stages of mineralisation. Here and there crushed grains of chert from the walls can be discerned, and in some places a little graphite is present, mainly as films on shear planes.

Carbonates in general are rare, though crystals of dolomite are found scattered through the quartz mosaic, and the filling sometimes has a narrow selvedge of the same mineral, with rare grains of calcite.

Talc, chlorite and sericite are found in the mortar which sometimes occurs in the mosaic, and aggregates of these three minerals are found as irregular masses throughout the vein.

Pyrite of both generations is found, though that of the later type is by far the more abundant. It occurs in all the various ways described in connection with the other ores, but only in the vein filling, not disseminated or scattered in the chert. Crystals of first generation pyrite are found in the filling, and in the chert itself, often surrounded by a narrow border of bladed quartz. Arsenopyrite is very rare, since this mineral usually prefers to deposit as scattered grains in the walls, a procedure apparently not possible in this case.

The sulphides in general occur in the form of much smaller grains or crystals in these ores than they do in the other types previously described, and are often found as small aggregates of minute grains, more or less loosely grouped together.

No gold was seen in the polished sections cut from specimens of the bar ores. This is not surprising, since most of these ores are of relatively low grade.

and in such cases the chance of intersecting gold particles in a few polished surfaces, individually not more than ½ square inch in area, is very small.

The thin veinlets which cement the breccia fragments show the same characteristics, though on a smaller scale, as those exhibited by the main fracture fillings.

When the chert which has been fractured and brecciated is of the "brassy" variety, containing myriads of tiny spheroids of pyrite, the latter have apparently not been affected in any way whatever by the passage of hydrothermal solutions, and the consequent deposition of the various minerals already mentioned. This shows to what a small extent the chert bar material itself has been affected by the solutions.

The photomicrograph on Plate XLVII is of a specimen of mineralised chert bar.

Conclusion

Classification and General

The general characteristics of the ores found on the property of New Consort Gold Mines - Sheba Section suggest that the period during which hydrothermal activity and its consequent mineral deposition took place was of considerable duration, and that the conditions of temperature and pressure changed through a large range.

The earlier minerals deposited are characteristic of the higher ranges of mesothermal deposition, but it is evident that such conditions did not apply for long, and that both temperature and pressure dropped considerably towards the end of the period of mineralisation.

It is to be expected that such high temperature minerals as tourmaline, topaz, pyrrhotite and arsenopyrite would not occur as abundantly as they do in the Noordkaap area, which is well within the metamorphic aureole of the de Kaap Valley Granite, where much higher temperatures and pressures prevailed. The Sheba ores are found outside the zone of such effects, though they obviously owe their origin to the same granite intrusion, and the minerals therefore are, for the most part, characteristic both in nature and in mode of occurrence, of lower ranges of temperature and pressure. The occurrence of the second generation of pyrite is particularly illustrative in this connection.

The control exerted over the mode of mineralisation in and near the fractures by external conditions, such as chemical and physical nature of wall rocks and the manner in which these rocks have reacted to fracturing, are very well illustrated by the differences which exist between the ores in Zwartkopje and Birthday sections in the green "schist" and the various shale and bar ores.

The peculiar structures found in certain parts of the bars suggest that at least part of these peculiar rocks is of organic origin, and that sulphur- and silica-secreting bacteria existed at the time of deposition of the rocks in the Moodies Series. If this is true, these phenomena are probably the earliest signs of organic life known in the South African subcontinent.

A great many mines and near-mines in the Barberton district have either been abandoned, or work under severe handicaps, owing to the difficulty of obtaining high extraction percentages on the unoxidised ore. In the ores in the zone of oxidation, it is in general possible to obtain low plant residues. These facts, in themselves, point to the reason for the general refractory nature of the Barberton gold ores, in that they suggest that the presence in the mill feed of fresh sulphides is inimical to a high gold recovery figure. Many of the ores contain refractory sulphides, such as arsenopyrite and stibnite. Stibnite as a general rule occurs in small amounts, and in itself does not therefore constitute a serious problem. Arsenopyrite generally gives rise to certain milling and cyanidation difficulties, but these can be overcome without serious trouble if other conditions are favourable, and if no other refractory minerals are present in large amounts.

It is significant that even such ores as those found in the workings of the New Consort Gold Mines and the New Consort Gold Mines - Sheba Section, in which the only sulphides present to any appreciable extent are arsenopyrite and pyrite, considerable difficulty is experienced in maintaining low final residue values. Other mines in the district have similar troubles with which to contend, even when pyrite is the only important sulphide present in the ores.

The results of the writer's microscopic examination of the ores handled by the New Consort Gold Mines, Ltd. indicate that at least one of the causes of high residues is the occurrence in the ores of gold far too finely divided for liberation by present grinding practice. Specimens of flotation concentrates and other mill pulps, mounted in dental cement and polished in the ordinary way, bear out this statement. The main cause of high residues in the New Consort plant is the presence, enclosed in the gangue minerals, of gold particles far beyond the reach of economic grinding methods. There is some fine gold enclosed in the arsenopyrite, but most of this is rendered accessible to cyanide solutions by the roasting process to which the plant sands are subjected.

In the case of the Sheba Section of New Consort Gold Mines, the problem is rather less easy of solution or alleviation. In this case minute particles of gold occur not only in the gangue, but also enclosed in pyrite and arsenopyrite, chiefly the former. The plant used for the treatment of these ores employs froth flotation as a concentrating process, and this naturally loses such fine gold as the grinding does not liberate from the gangue. So far[1] no practicable method has been devised for the satisfactory treatment in this country of the flotation concentrates, which contain a considerable amount of gold enclosed in pyrite, and of such size as to defy liberation by ordinary grinding methods. At present these concentrates are shipped to custom smelters in the United States of America, but in recent years the cost of realisation has risen to such a point that even a relatively inefficient method of extraction of the gold

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[1]October, 1942.

from the concentrate would be attractive. Most of the gold in the Sheba Section concentrates is enclosed by or intimately associated with, pyrite, and a considerable though unknown proportion is so finely divided as to be beyond the reach of ordinary grinding processes. It is not known, however, exactly what proportion of the gold present would not be liberated by super-fine grinding, and this can be determined only by experiment. Such a proportion would have to be fairly high under present conditions to discount the advantages of local treatment.

The best results would undoubtedly be obtained by a sweet roast of the concentrates, as such a process would liberate for solution by far the greater part of the contained gold. There are practical difficulties in the way of such a process, but it is, nevertheless, considered that, should it become possible satisfactorily to oxidise off the sulphides, such a method of liberation would be preferable to and certainly more efficient than fine grinding.

Another method which might yield satisfactory results is one not well known in this country, that is, the employment of a combined roasting and reverberatory smelting process for the extraction of the gold from these concentrates. Such a process would require as a "carrier" a high-sulphur base metal concentrate, preferably a copper concentrate. By judicious roasting and fluxing it should be possible to produce, first a matte and finally a blister copper containing the gold from the Sheba concentrates. Such a blister could then be electrolytically refined in this country, or shipped abroad at a considerably lower realisation cost than that being paid at present. The Mamre Gold Mine pyrrhotite-chalcopyrite-gold concentrates, which are also treated abroad at present, should be admirably fitted for such a process, which would undoubtedly give a higher recovery figure than a grinding and cyanidation method.

Future and Exploration

Future prospects at the Sheba Section are not as hopeful as are those at New Consort Gold Mines, chiefly because the general distribution of the main fracture systems obeys no known law. Individual gold-bearing fractures should, of course, always be followed and opened up as far as possible in both directions on strike and down dip. Such a process at Sheba, however, does not offer prospects such as those which exist at Noordkaap. There are a vast number of fractures, most of them not persistent for any important distance, in the rocks on the Sheba Section property, but all the "new" ores which have been opened up in recent years were known to the old prospectors. No important fracture or system of fractures has been newly discovered in recent years.

It seems possible that the Insimbi Fracture might lead to a system of fractures similar to those in the Zwartkopje Section, in the south green "schist". Should this be the case, ore bodies of considerable importance may exist there. Similarly, some of the fractures which have been mined under the Zwartkopje Bar might carry payable values in the shales north of the Southern Cross Bar. One attempt has been made to follow up this possibility, but so far with little success. The lower and western part of the Birthday area holds out considerable promise, as a fracture of the Zwartkopje type has been exposed there, and this might well be the fore-runner of others lower down.

It is very unlikely that any undiscovered fracture of prime importance exists on the property, but others of relatively small extent may be opened up, and found to repay mining and treatment for a time. It is considered that the main prospects should be pursued underground. As has already been stated, exploratory work in the bar-"schist" group should be conducted along the Zwartkopje Bar-green "schist" contact, with occasional cross-cuts south, to expose the south shales.

In an area of this type, where the individual ore bodies are usually fairly widely separated and of relatively small size, a very large amount of carefully planned development work is vitally necessary if production is to be maintained for any considerable period.

General Concluding Remarks

A good deal has been written about the general geology of the Barberton district, and particularly about the gold deposits found in the area. These deposits are of very great interest, and in many cases are probably not as important as they might be. This is due to several causes: the geological problems involved in the exploitation of the ore bodies, the extraction difficulties more or less universal in the district, transport and other difficulties related to the mountainous terrain, the irregularity of gold distribution, and current misconceptions concerning the gold deposition in general.

The geological problems involved in mining and exploitation of the ore bodies are certainly of considerable importance, and have constituted the chief deterrent to more large-scale activity in the district. In general, the gold occurrences of the Barberton district can be said without fear of exaggeration to be among the most complex known. It has been shown, however, that careful and detailed geological study can go a long way towards reducing the element of risk attendant upon exploitation of these deposits; it is of great assistance in mapping out economical development which will cover the ground cheaply and yet be unlikely to overlook anything of importance; it reduces unnecessary exploration; it generally simplifies mining and prospecting operations, and so increases to an appreciable extent the chances of profitable operation. This is so because even in the most complex and apparently confused cases some order can usually be found, and some relatively simple law determined by which the gold distribution is controlled. It is thus usually possible to lay down some system upon which general exploratory work can be based. Data obtained from geological investigation of the known mineralised and exploited areas serves as a basis for prospecting work, conducted at other points, and also furnishes information from which the promise held out by unexplored areas may be judged.

Hall[1] apparently considers that there is some justification for the belief that in some mines the ore shoot decreases in width as the workings reach lower levels. Such a conclusion certainly does not hold in so far as the New Consort Gold Mines and the New Consort Gold Mines - Sheba Section are concerned. On the New Consort Mine the shoots are of irregular shape and size, and show no sign of decreasing in size with depth. At Sheba, particularly in the cases

[1]Geological Survey Memoir No. 9, p. 238.

of the Intombi and Zwartkopje Sections, the extent of the mineralised zone increases from the surface downwards. Some of the workings in the district have been abandoned at relatively shallow depths, and this fact may to a certain extent account for the misconception above mentioned. Such factors as the refractory nature of the fresh ores and the pinching of one shoot above another which is unexposed undoubtedly have contributed to the premature abandonment of many of the mineralised areas. The idea is held by some that surface enrichment is one of the factors concerned in this connection. It does not seem likely, however, that processes of this kind have had any really significant effect; at least, they have certainly had no noticeable effects in the two areas studied by the writer.

The whole of the area has been very thoroughly prospected, and innumerable pits, trenches and other more extensive workings are to be found throughout the district, and it has been generally found that practically all fractures and other auriferous bodies in the area have been examined to a greater or lesser extent in the past. It is, however, frequently worth examining old workings and prospects, since they were in most cases abandoned at a time when the price of gold was far lower than it is at present, and when transport difficulties were a more severe handicap than they are now. Thus many places which were abandoned or barely exposed in the early days are proving themselves to be workable propositions under present circumstances.

The refractory nature of many of the gold ores in the Barberton District has been the cause of a great deal of trouble, and has in some cases forced a cessation of mining operations. It is considered, however, that the use of modern methods of microscopy in the study of the ores and mill pulps can be of invaluable assistance, and will in many cases undoubtedly yield information leading to more efficient gold extraction. Such work can be of great value in guiding metallurgical research, in that it can point out pitfalls and dead-end lines of investigation, thereby effecting saving of time, and curtailment of unnecessary expenditure.

Unfortunately, the value of such microscopic investigation done in conjunction with metallurgical research has in the past not been thoroughly appreciated.

It is the opinion of the writer that the value of the gold deposits of the Barberton District has not been widely enough realised, and that this area would certainly repay more large-scale examination and exploitation than it has so far enjoyed.

TABLE I

Standard Screen Mesh	Size of largest particle passing screen. (μ)
60	270
80	200
90	180
100	160
150	100
200	75
300	46
400	35
500	27
600	23
700	18
800	16
900	14
1000	13
1500	8.5
2000	6.0
3000	4.0

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Facing Pl. XXVII

View of New Consort Gold Mines, looking north from the rising ground between the Noordkaap River and the De Kaap Valley.

Plate XXVII

Facing Pl. XXVIII

View of New Consort Gold Mines - Sheba Section,
looking east down the Zwartkopje Va[illegible]y

Plate XXVIII

Facing Pl. XXIX

"Footwall Rocks", New Consort Gold Mines, Ltd.

Fig. 1 Salmon pink and yellow groundmass with large green tourmaline metacrysts.

Fig. 2 Dark green groundmass consisting mainly of chlorite, with metacrysts of black tourmaline.

Fig. 3 Schistose rock with tourmaline crystals in all azimuths in plane of schistosity.

Fig. 4 Intensely sheared schistose rock consisting almost entirely of talc folia.

Scale inches in each case.

Plate XXIX

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Facing Pl. XXX

"Hanging wall rocks". New Consort Gold Mines, Ltd.

Fig. 1 Weathered surface of cordierite hornfels. Ridges due to cordierite.

Fig. 2 "Spotted" quartz biotite schist. Witkoppies.

Auriferous arsenopyritic "reef". New Consort Gold Mines, Ltd.

Fig. 3 Specimen of Consort reef, showing bands containing arsenopyrite needles; gold content about 20 dwt/ton.

Scale inches in each case.

Fig. 1

Fig. 2

Fig. 3

Facing Plate XXI

Footwall Rocks

Fig. 1 Curved masses of tremolite needles in tremolite schist. Crossed Nicols, x65.

Fig. 2 Radiating antigorite in serpentine. Crossed Nicols, x65.

Fig. 3 Biotite and tremolite with magnetite crystals in tremolite schist. Plane polarised light, x65.

Fig. 1

Fig. 2

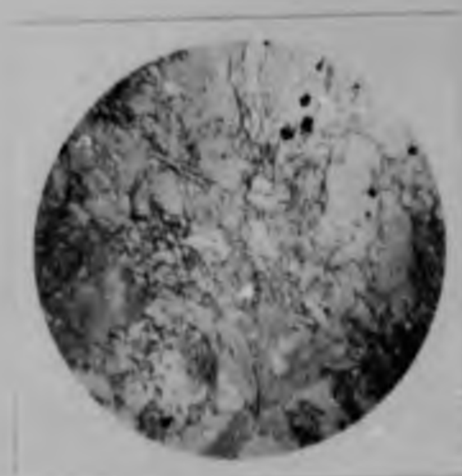


Fig. 3.

Facing Plate XXXII

Hanging wall Rocks

Fig. 1 Quartz-biotite schist containing andalusite and pargasite needles, the latter exhibiting decussate structure. Plane polarised light. x65.

Fig. 2 Quartz-biotite-garnet schist showing bending of foliation around garnet metacryst. Plane polarised light. x65.

Fig. 3 Zircons with pleochroic haloes in the biotite in quartz-biotite schist. Plane polarised light. x65.

Plate XXXII

Fig. 1

Fig. 2

Fig. 3

Facing Plate XXXIII

"Bar"

Fig. 1 Banded green and brown "Bastard Bar." Laminations of fine quartz and green chloritic matter, with a vein of quartz along a foliation plane. Crossed Nicols. x65.

Fig. 2 Highly siliceous black "bar" with chains of minute tourmaline and biotite grains along foliation planes. Plane polarised light. x65.

Fig. 1

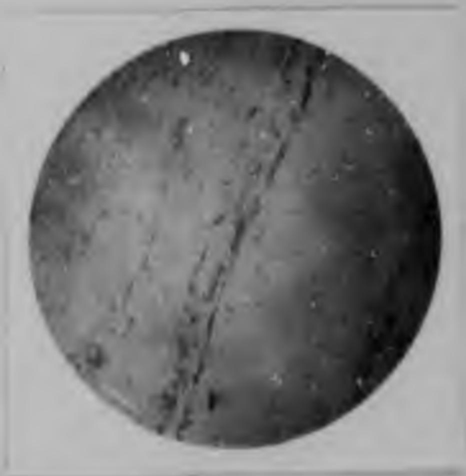


Fig. 2

Facing Plate XXXIV

Pegmatites and their Wall Rocks

Fig. 1 Pegmatite, showing quartz, bent oligoclase laminae and well developed mortar structures. Crossed Nicols, x65.

Fig. 2 Biotite replacing tremolite in footwall rocks near pegmatite. Plane polarized light, x65.

Fig. 3 Palimpsest schistosity in completely silicified hanging wall rocks near pegmatite. Crossed Nicols, x65.

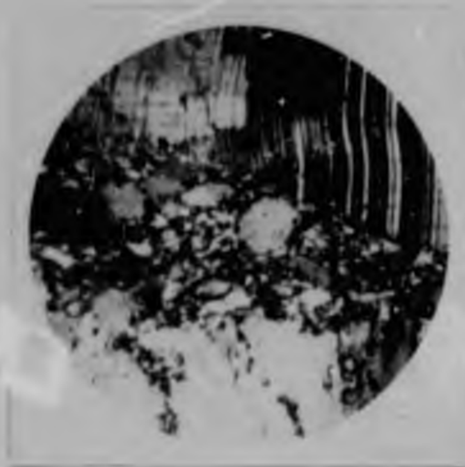


Fig. 1

Fig. 2

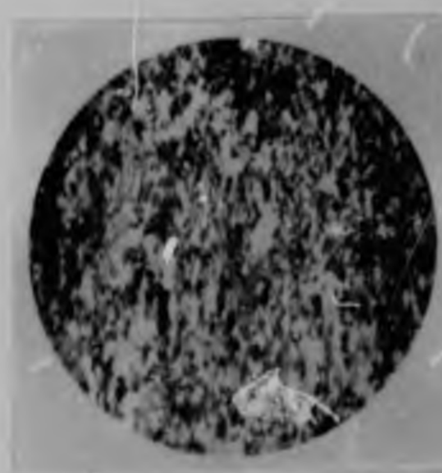


Fig. 3

Facing Plate XXXV

Contact Ores

Fig. 1 Sulphides (pyrrhotite) replacing tremolite along cleavages, and avoiding muscovite. Plane polarised light. x65.

Fig. 2 Arsenopyrite needles in quartz in a veinlet in footwall rock. Plane polarised light. x65.

Fig. 3 Arsenopyrite needles in "bar". Plane polarised light. x65.

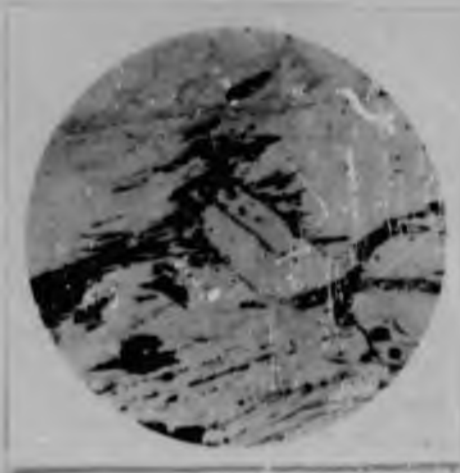


Fig. 1

Fig. 2

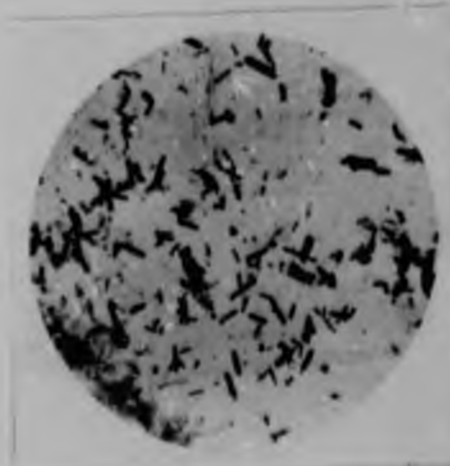


Fig. 3

Facing Plate XXXVI

Contact Ores

Fig. 1 Pyrrhotite veinlets in tremolite cleavages. Reflected light. x100.

Fig. 2 Arsenopyrite veinlets in fold tension cracks in tourmaline, on a small drag fold. Reflected light. x100.

Fig. 3 Arsenopyrite (As) replacing pyrrhotite (P) and Chalcopyrite (Ch). Chalcopyrite not so easily replaced, forming islands and promontaries in the arsenopyrite. Reflected light. x100.

Fig. 1

Fig. 2

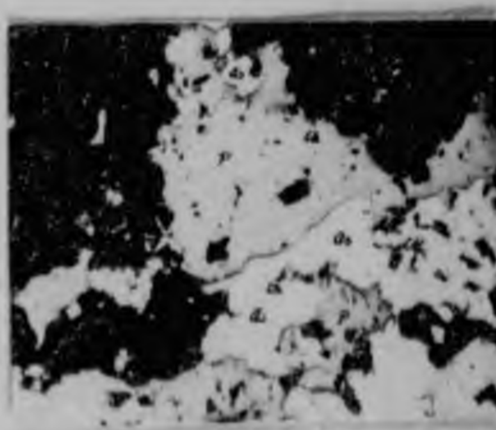


Fig. 3

Facing Plate XXXVII

Fracture Ores

Fig. 1 Tiny gold veinlets in cracks and cleavages in tremolite, in footwall rocks. No sulphides. Reflected light, x100.

Fig. 2 Arsenopyrite bleb with "frayed" boundaries. Reflected light, x100.

Fig. 3 Galena in footwall rocks. Irregular cleavage pits. Reflected light, x100.

Fig. 4 Minute (2-10 μ) gold particles (Au) in arsenopyrite. Reflected light, x400.

Plate XXXVII

Fig. 1

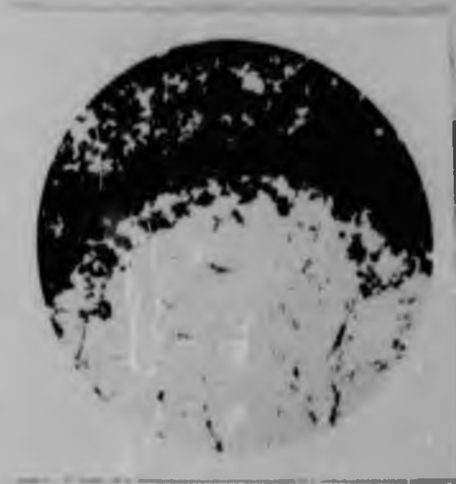


Fig. 2

Fig. 3

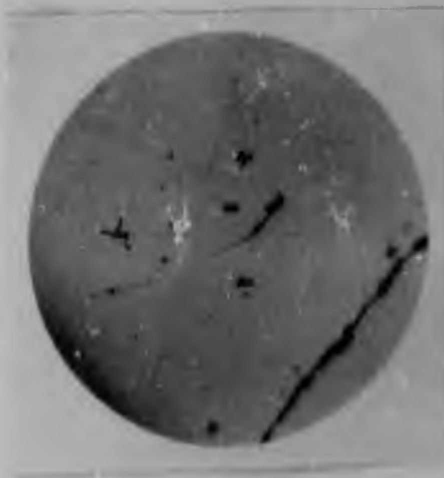


Fig. 4

Facing Plate XXXVIII

Fault Ores

Fig. 1 Broken and bent arsenopyrite needles in bar material in fault ore body. Plane polarised light. x65.

Fig. 2 Broken arsenopyrite needle with parts displaced. Bar material in fault ore body. Reflected light. x100.

Fig. 3 Cross-sections of arsenopyrite needles in fault ore. Corners of prisms have been ground off by the movement in the fault. Reflected light. x100.

Plate XXVIII

Fig. 1

Fig. 2

Fig. 3

Facing Plate XXXIX

The Shales

Fig. 1 Coarse grained shale. Quartz mosaic with carbonates, sericite, etc. Crossed nicols, x65.

Fig. 2 Sheared shale near the Zwartkopje Bar, showing shear planes, elongation of particles, etc. Crossed nicols, x65.

Plate XXXIX

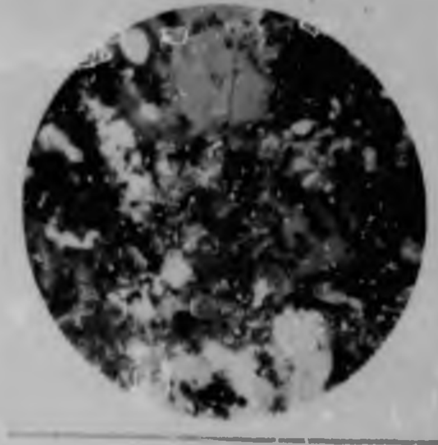


Fig. 1

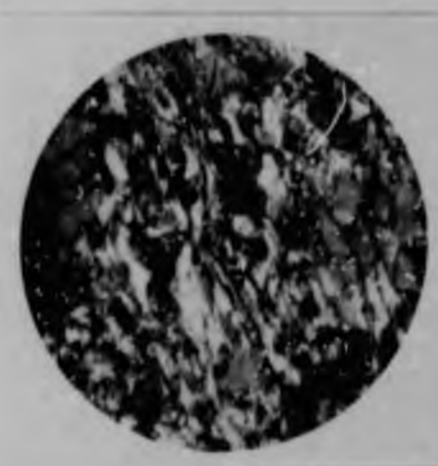


Fig. 2

Facing Plate XL

The Bars

Fig. 1 Zwartkopje Bar. Black transparent chert with spots rich in minute opaque inclusions and carbonate grains. Plane polarised light. x65.

Fig. 2 Zwartkopje Bar. Fine chert with minute contemporaneous spherical grains of pyrite, later quartz veinlets, and first generation pyrite crystals with fibrous or bladed quartz borders on the edges more or less perpendicular to the stratification. Plane polarised light. x65.

Fig. 3 Zeolite spheroid in black chert bar. Plane polarised light. x65.

Fig. 4 Contemporaneous pyrite spheroids and first generation pyrite crystals in Zwartkopje Bar. Reflected light. x65.

Plate XV

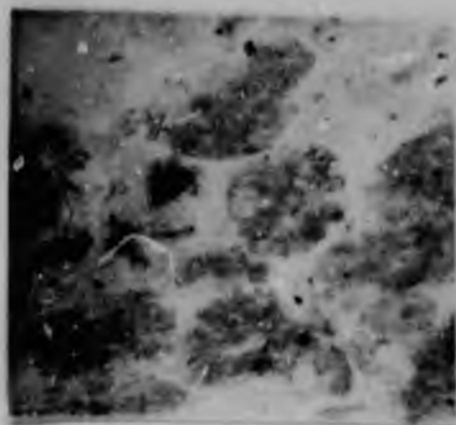


Fig. 1

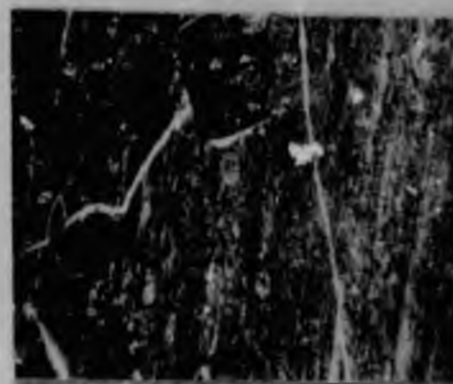


Fig. 2

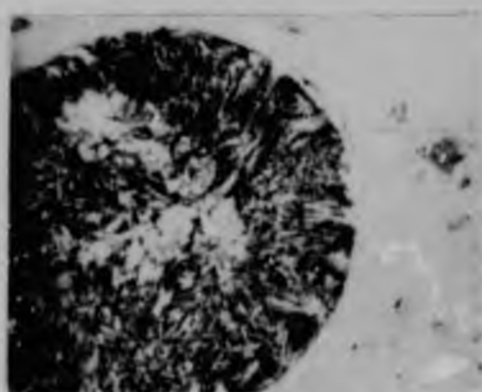


Fig. 3

Fig. 4

Facing Plate XLI

The Green "Schist"

Fig. 1 Foliae containing talc, chlorite, rutile and first generation pyrite crystals, in a vivid green sheared zone in the green "schist". Plane polarised light, x65.

Fig. 2 Pseudomorphs after a mineral of acicular habit in recrystallised and subsequently hydrothermally altered rock. Plane polarised light, x65.

Fig. 3 Partially comminuted grain of quartz in a sheared layer. Crossed nicols, x65.

Plate XLI

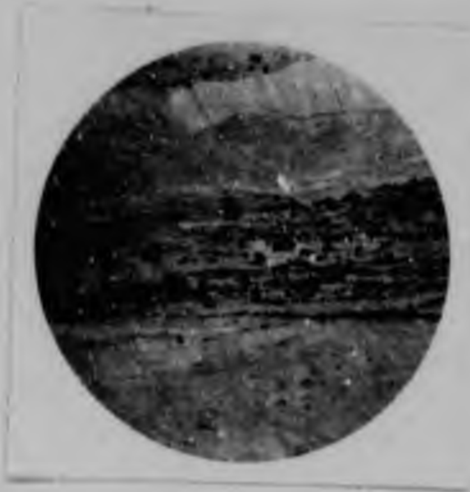


Fig. 1

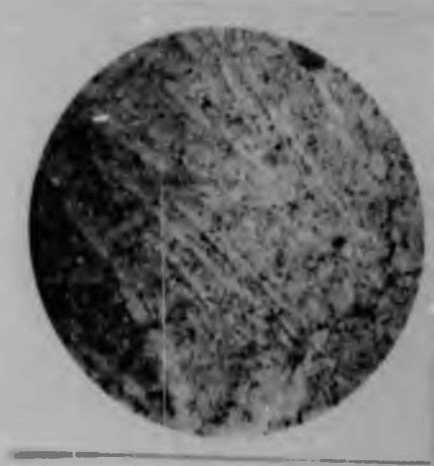


Fig. 2

Fig. 3

Facing Plate XLII

The Gray "Schist"

Fig. 1 Soft sheared rock consisting of chloritic matrix containing rounded grains of carbonates and quartz. and with later crystals of dolomite and first generation pyrite. Plane polarised light, x65.

The Dykes

Fig. 2 Masses of altered felspar needles with chlorite pseudomorphs after pyroxenes, etc. Plane polarised light, x65.

Plate XLII

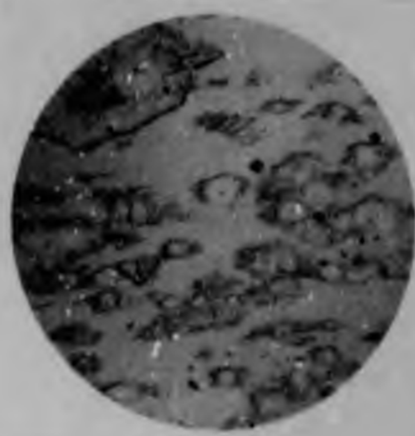


Fig. 1

Fig. 2

Facing Plate XLIII

Green "Schist" Ores

Fig. 1 Composite grains of first and second generation pyrite with intermediate zones and inclusions of gangue. Reflected light, x100.

Fig. 2 Large composite grain, consisting of first generation pyrite crystal, and second generation pyrite shell, with intermediate shell of quartz, etc. Reflected light, x100.

Fig. 3 Composite grains of first and second generation pyrite, the latter in the form of shells with minute particles of gold (Au). Reflected light, x100.

Fig. 4 Loose aggregate of second generation pyrite as shells, some with nuclei of gangue, and others with composite nuclei of first generation pyrite and gangue. Such aggregates constitute the fine grained massive pyrite characteristic of well mineralised areas. Reflected light, x100.

N.B. In these photomicrographs the gangue within the second generation pyrite shells appears to have a notably lighter colour than the external gangue. This is due to reflection from that part of the second generation pyrite shell which is below the surfaces of the sections.

Plate XLIII

Fig. 1

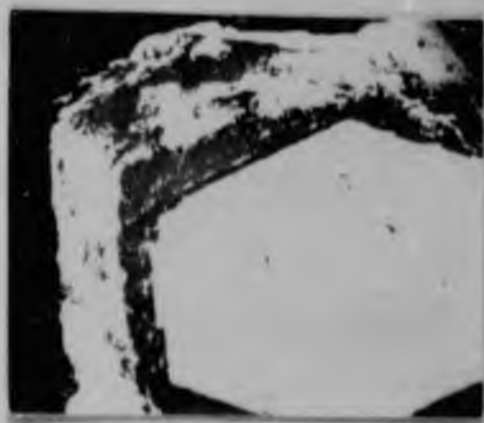


Fig. 2

Fig. 3

Fig. 4

Facing Plate XLIV

Green Schist Ores

Fig. 1 Particles of gold (yellow) zonally arranged as inclusions in composite pyrite grains. The zone of gold particles marks the passage from first generation pyrite crystal nucleus to second generation shell. Some of the gold particles are of very small size. Reflected light. x100.

Fig. 2 Intimate association of coarse and finely divided gold (yellow) and chalcopyrite (white) with occasional small grains of pyrite (white, showing relief.) Reflected light. x100.

Plate XLIV

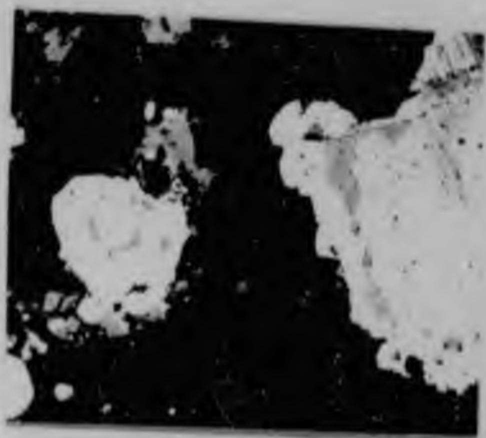


Fig. 1

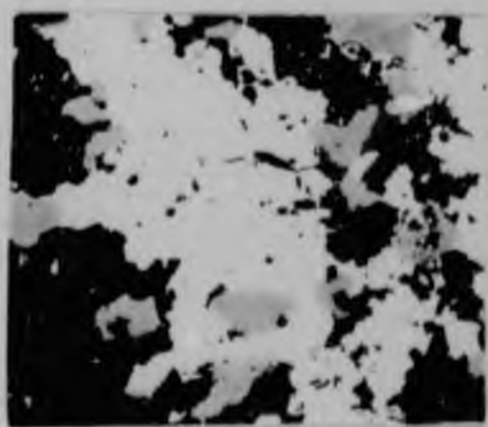


Fig. 2

Facing Plate XLV

Green "Schist" Ores

Fig. 1 Skeletal needles of arsenopyrite. Reflected light. x100.

Fig. 2 Arsenopyrite crystals traversed on cleavage planes by large numbers of thin veinlets of iron oxides. Reflected light. x100.

Fig. 3 Arsenopyrite needles in quartz, in a mineralised, fractured zone. Plane polarised light. x65.

Plate XLV

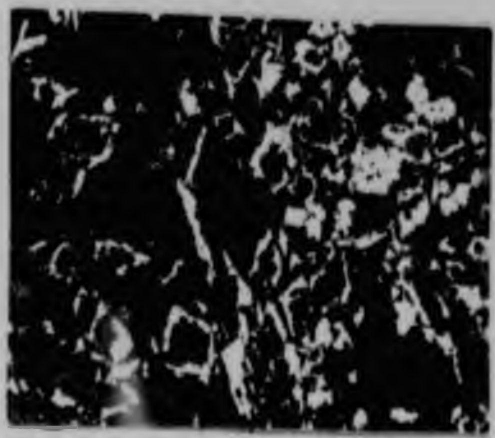


Fig. 1

Fig. 2

Fig. 3

Facing Plate XLVI

Shale Ores

Fig. 1 Carbonate "spots" in sheared shale near a mineralised zone on the Intombi Fracture. Plane polarised light, x65.

Fig. 2 Irregular grains of pyrite and needles of arsenopyrite in mineralised shale. Plane polarised light, x65.

Fig. 3 Very coarse bladed quartz between two masses of pyrite in mineralised shale near Intombi Fracture. Crossed nicols, x65. (This specimen has almost the appearance of flamboyant quartz.)

Plate XLVI

Fig. 1

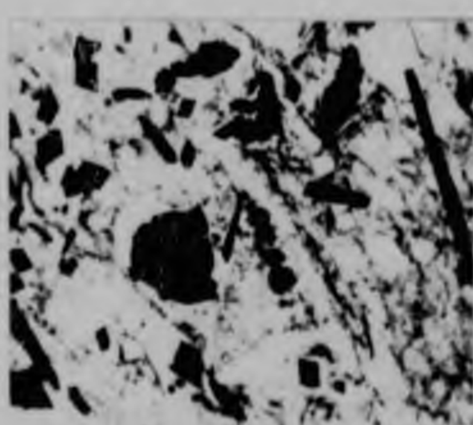


Fig. 2

Fig. 3

Facing Plate XLVII

Bar Ore

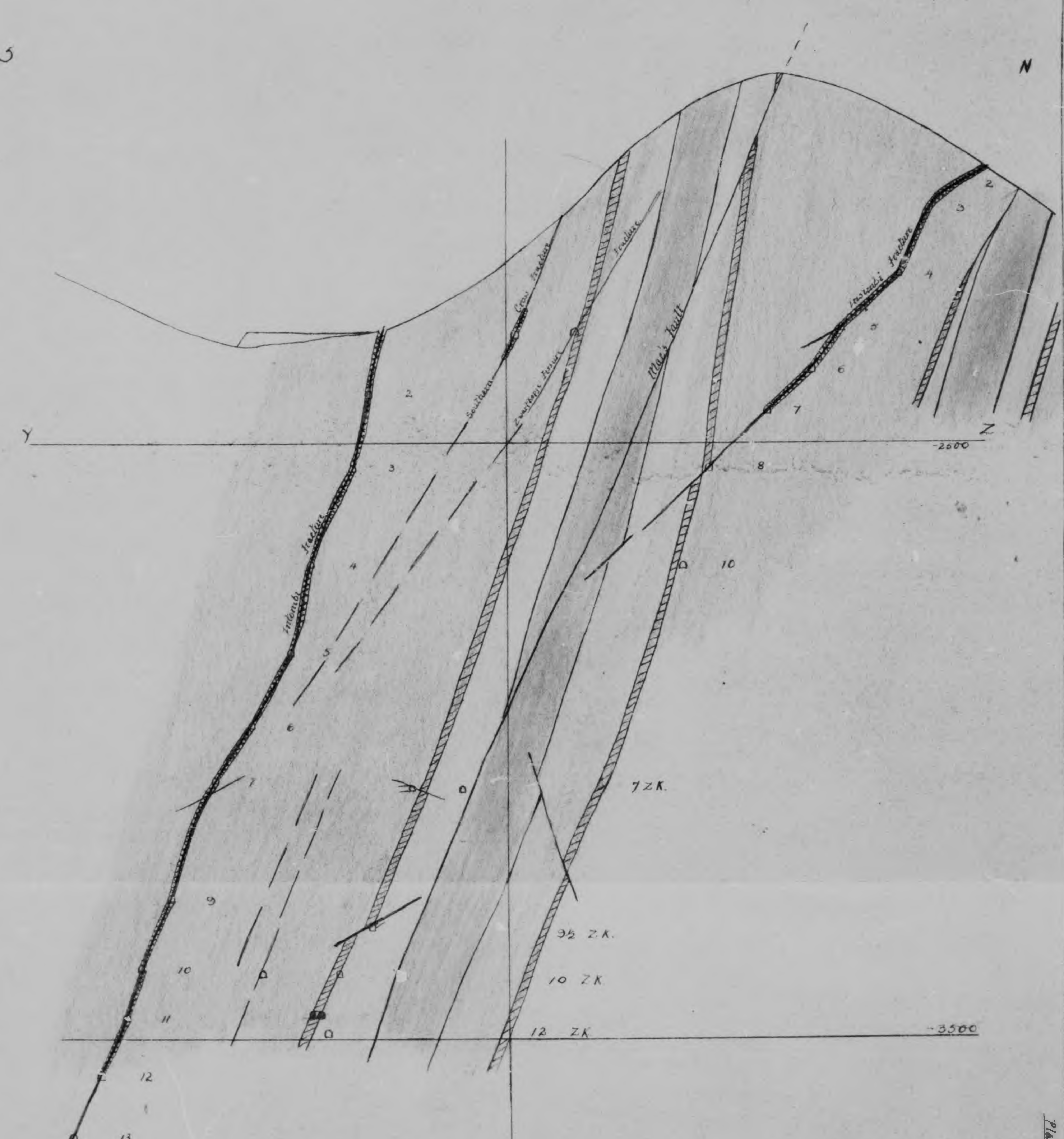
Black chert bar (Zwartkopje) of the "brassy" type, with minute pyrite spheroids, shattered near a fracture and cemented by quartz veinlets. Pyrite grains of second generation and crystals of first generation are present. The mass constitutes a "crackle breccia". Plane polarised light, x65.

Plate XLVII

LIST OF PLATES IN VOLUME II

	Plate No.
General Geological Map of the Barberton District	I
Geological Map, New Consort Gold Mines, Ltd.	II
Geological Map of the Sheba Hills Area	III
Geological Map, New Consort Gold Mines - Sheba Section	IV
Vertical Geological Cross Sections, New Consort Gold Mines, Ltd.	V - XI
Vertical Geological Cross Sections, New Consort Gold Mines - Sheba Section	XII - XXVI

Plate XXIV



Geological Section Y Z
1:2000

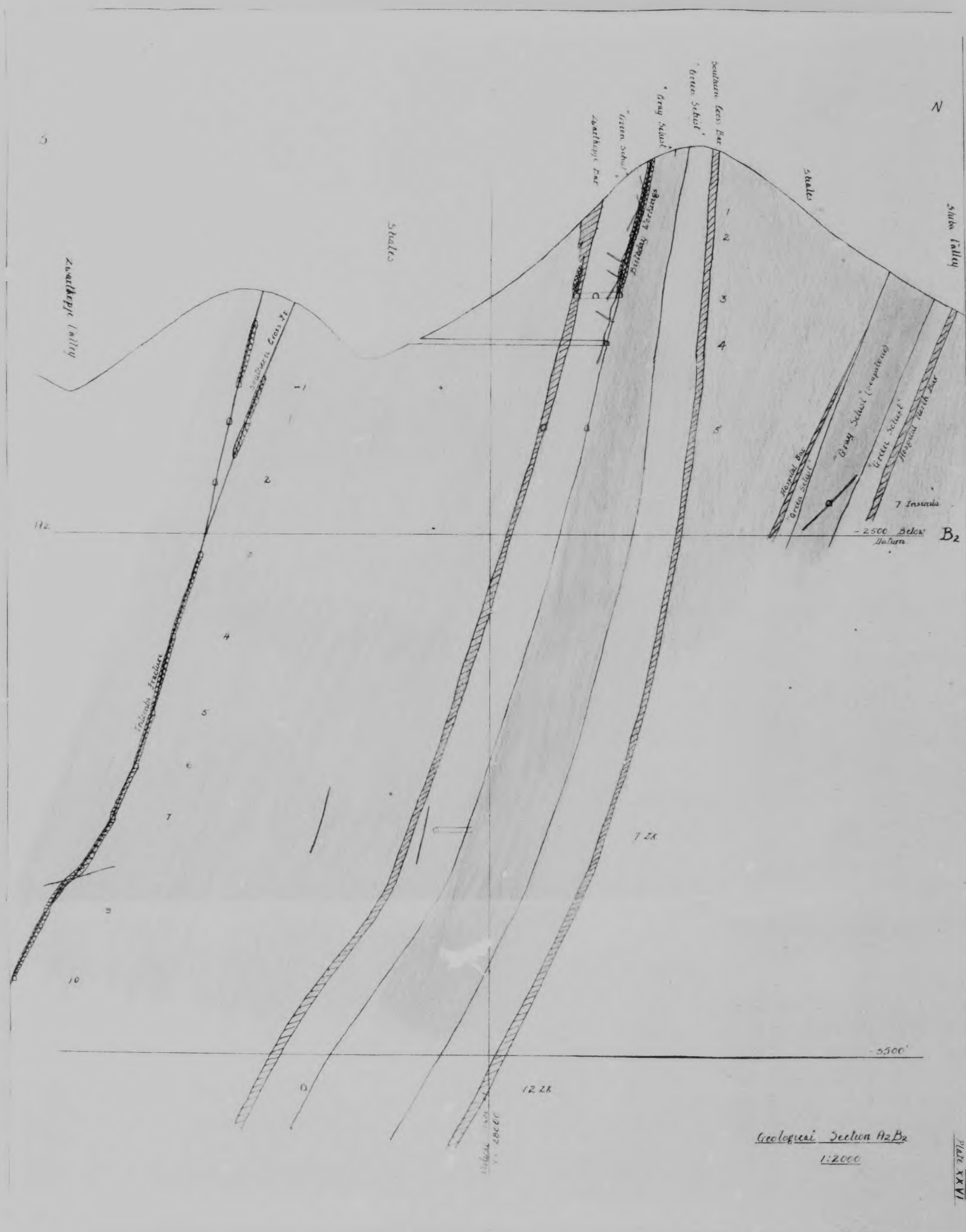


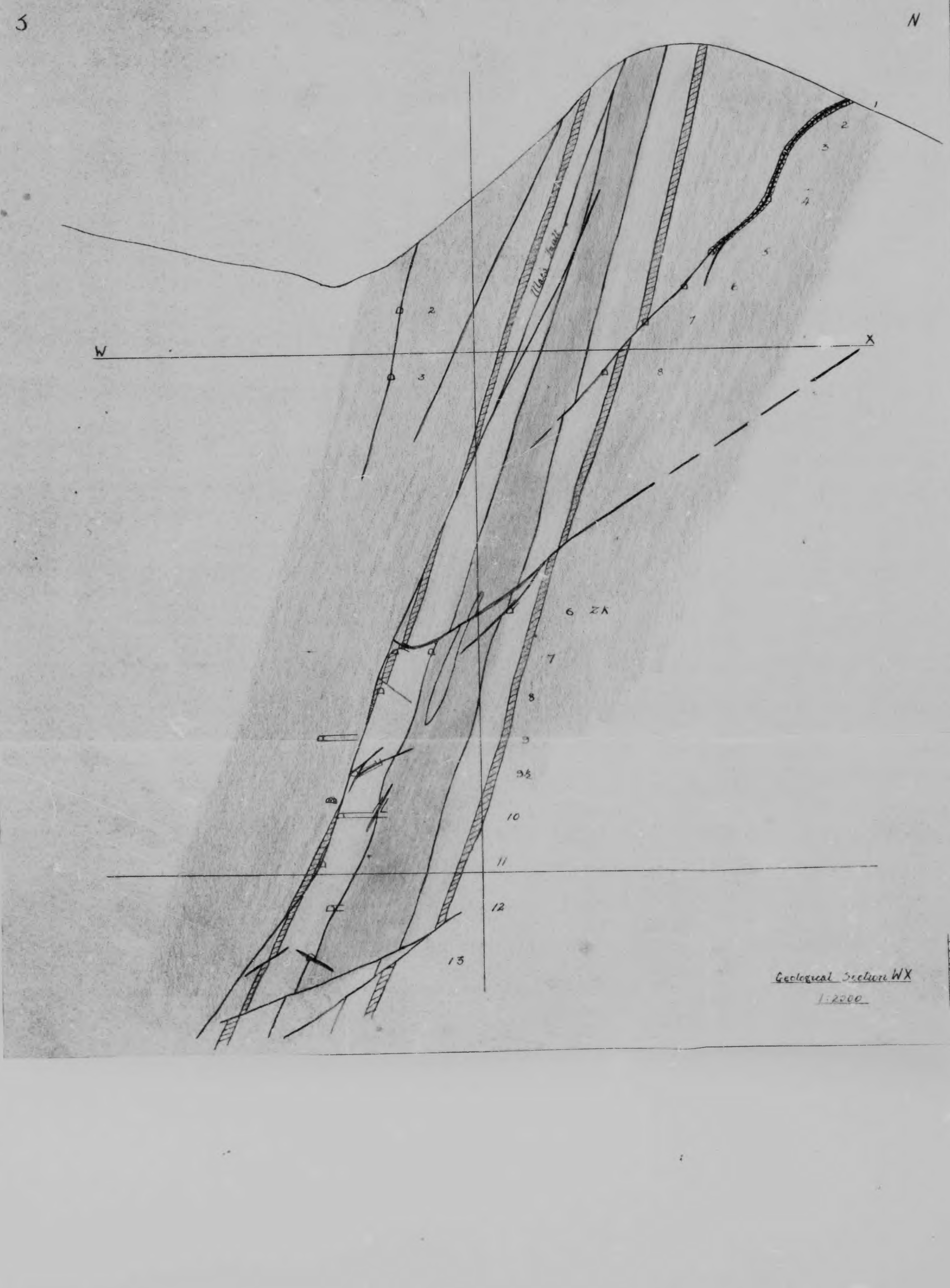
Plate XXVI
Geological Section A_2B_2
1:2000
N
S
Sheba Valley
Shales
Southern Cross Bar
"Green Schist"
"Gray Schist"
"Green Schist"
Zwartkopje Bar
Shales
Zwartkopje Valley
B_2
-2500 Below Datum
5500'

Plate XXV

Geological Section A₁ B₁

1:2000

Plate XXIII



Geological Section WX

1:2200

Geological Sect. III

1:2000

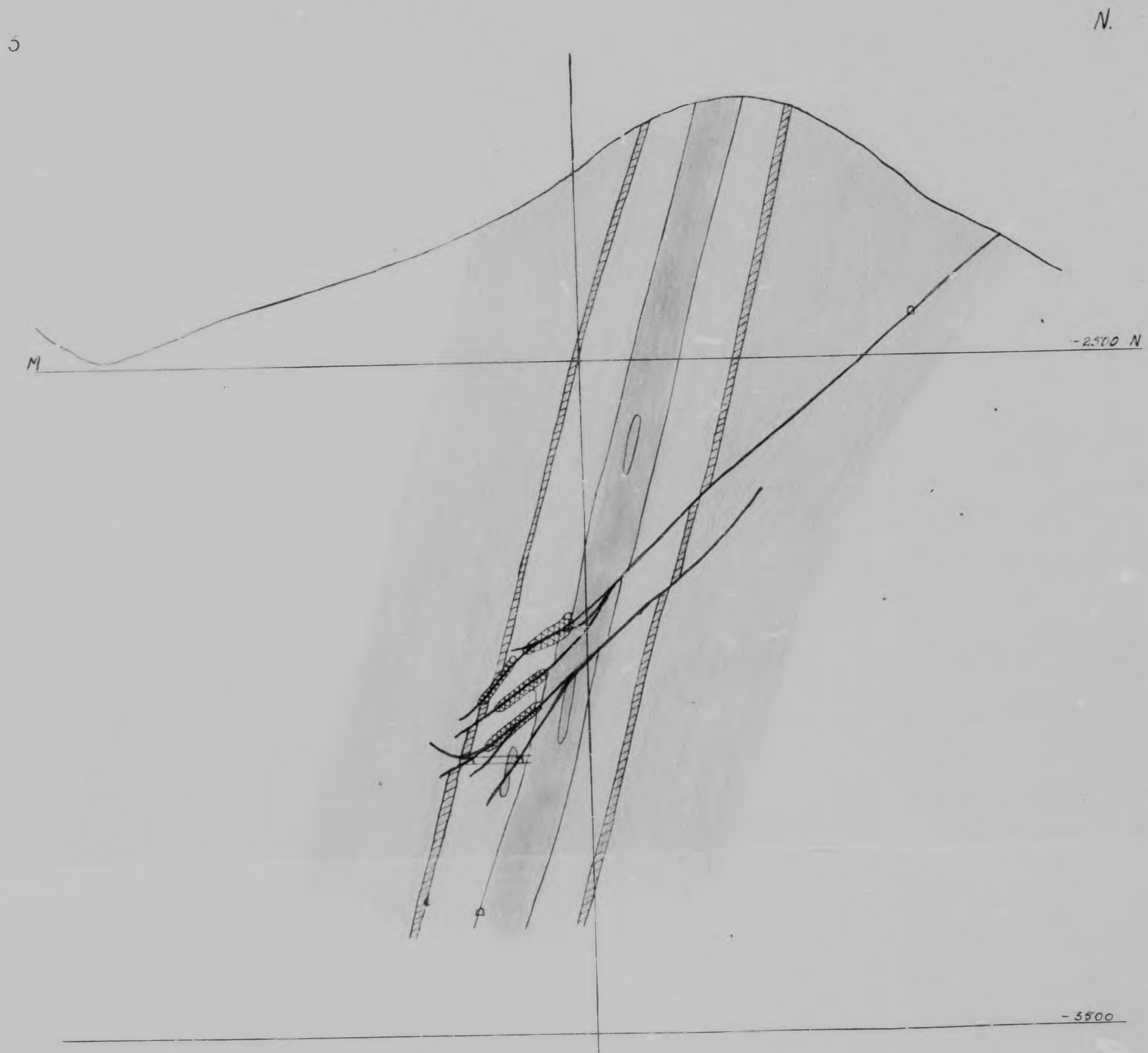
Plate XXII

ate XXI

Plate XI

Plate XIX

Geological Section Of

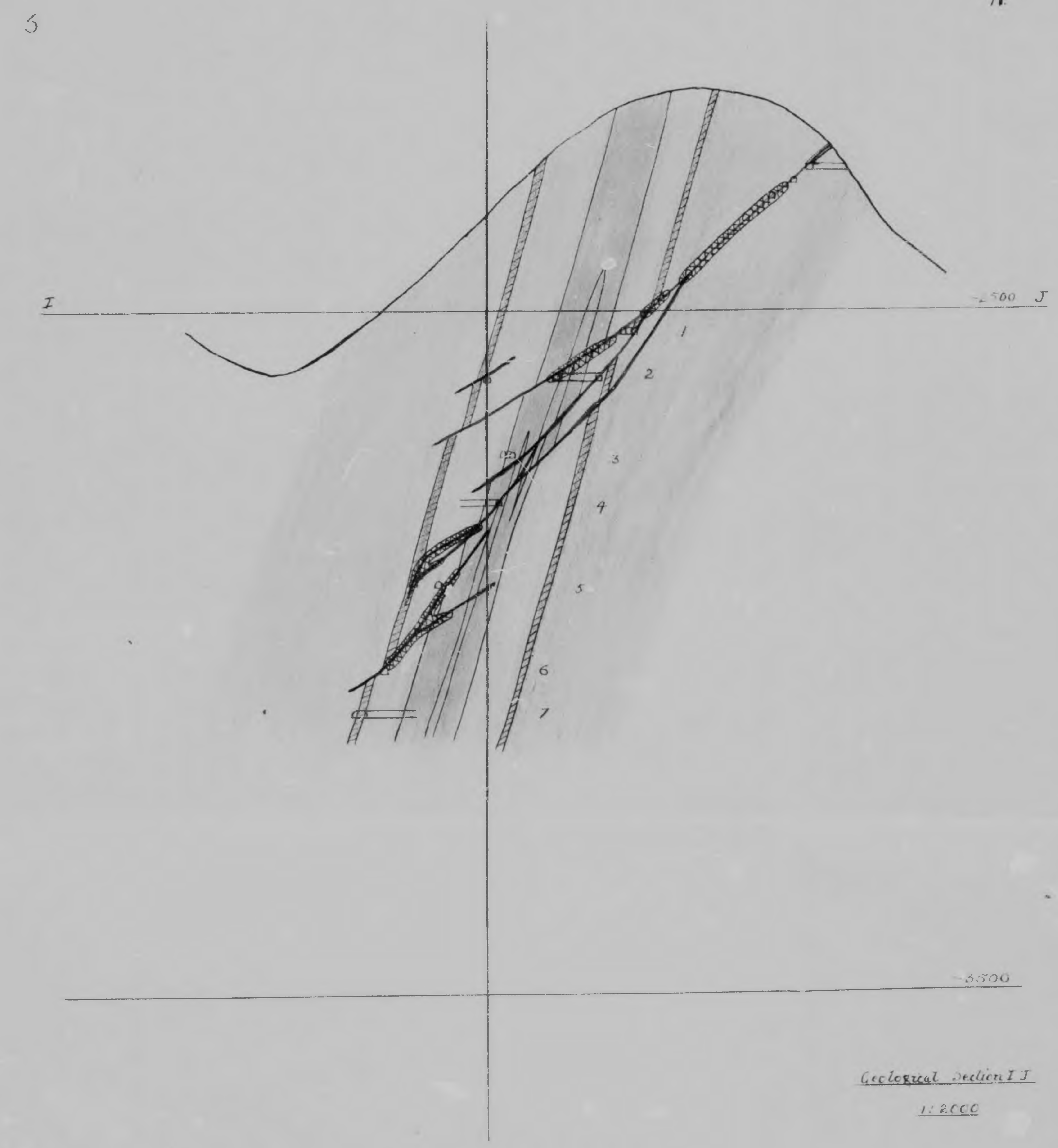


Geological Section MN

1:2000

Plate XVIII

Plate XVII



Geological Section IJ

1:2000

Plate XVI

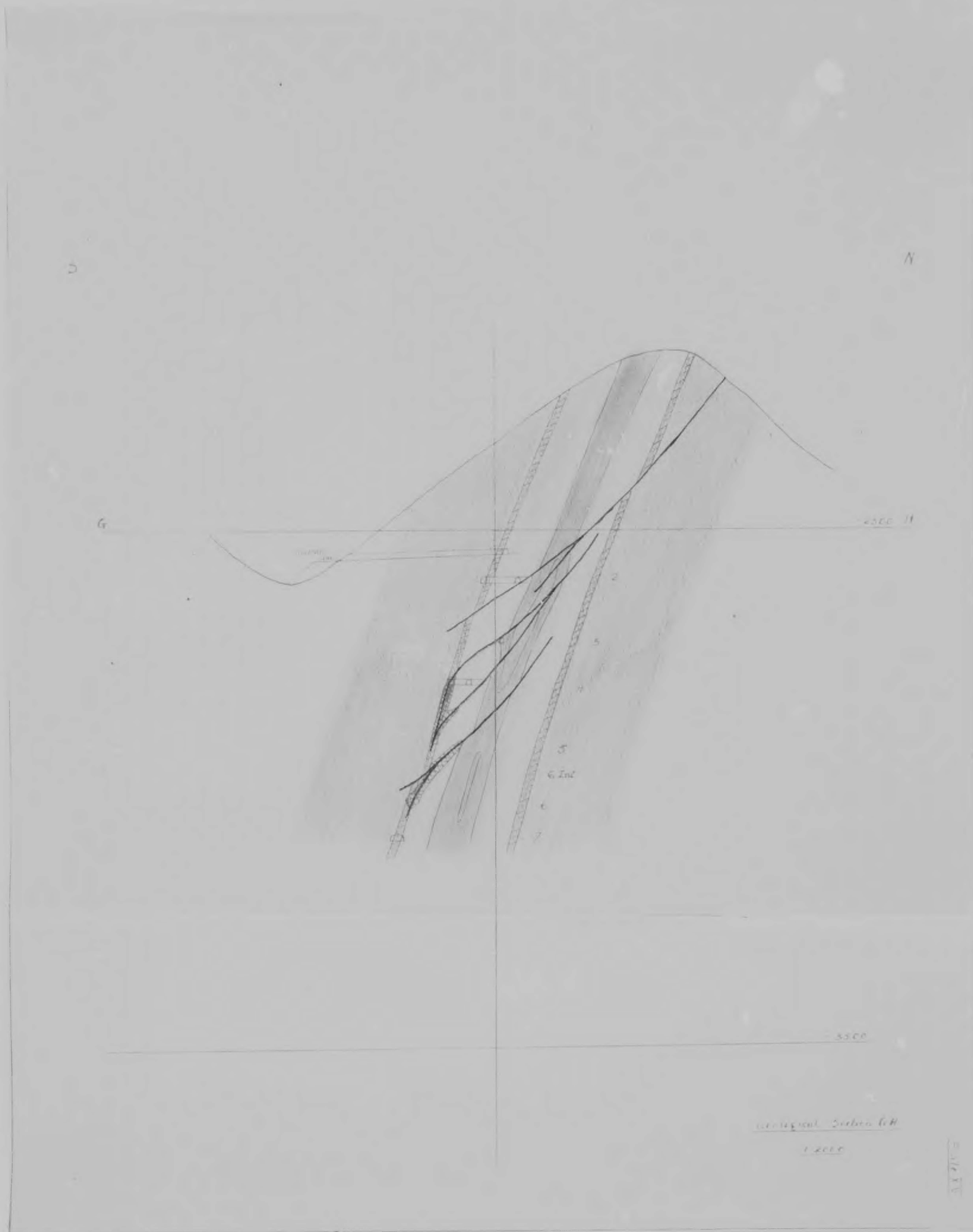

S
N
G
3500
Geological Section G-H
1:2000

Plate XIV

Plate XII


N
Shales
Grey
South
Zwartkopje Bar
Basic Dykes
Shales
Zwartkopje Shaft

Plate XI

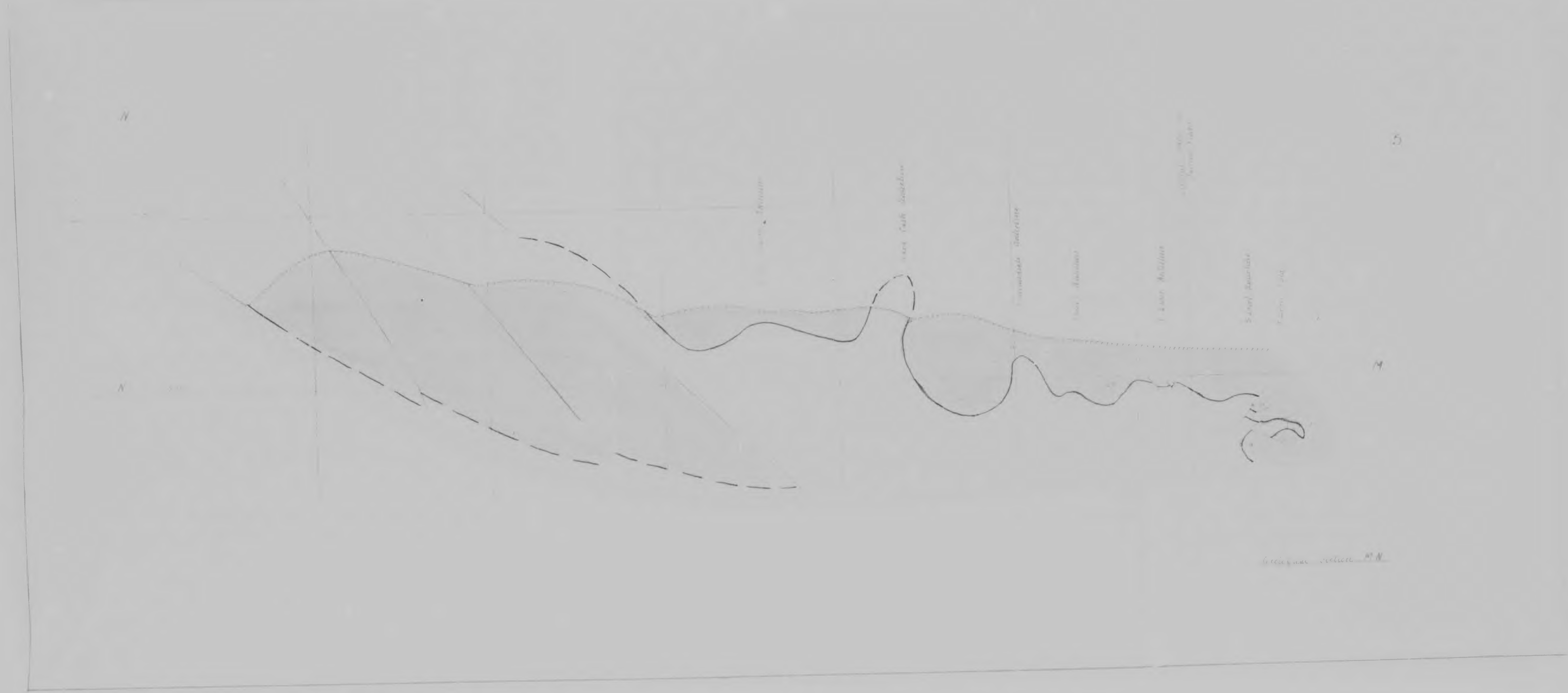
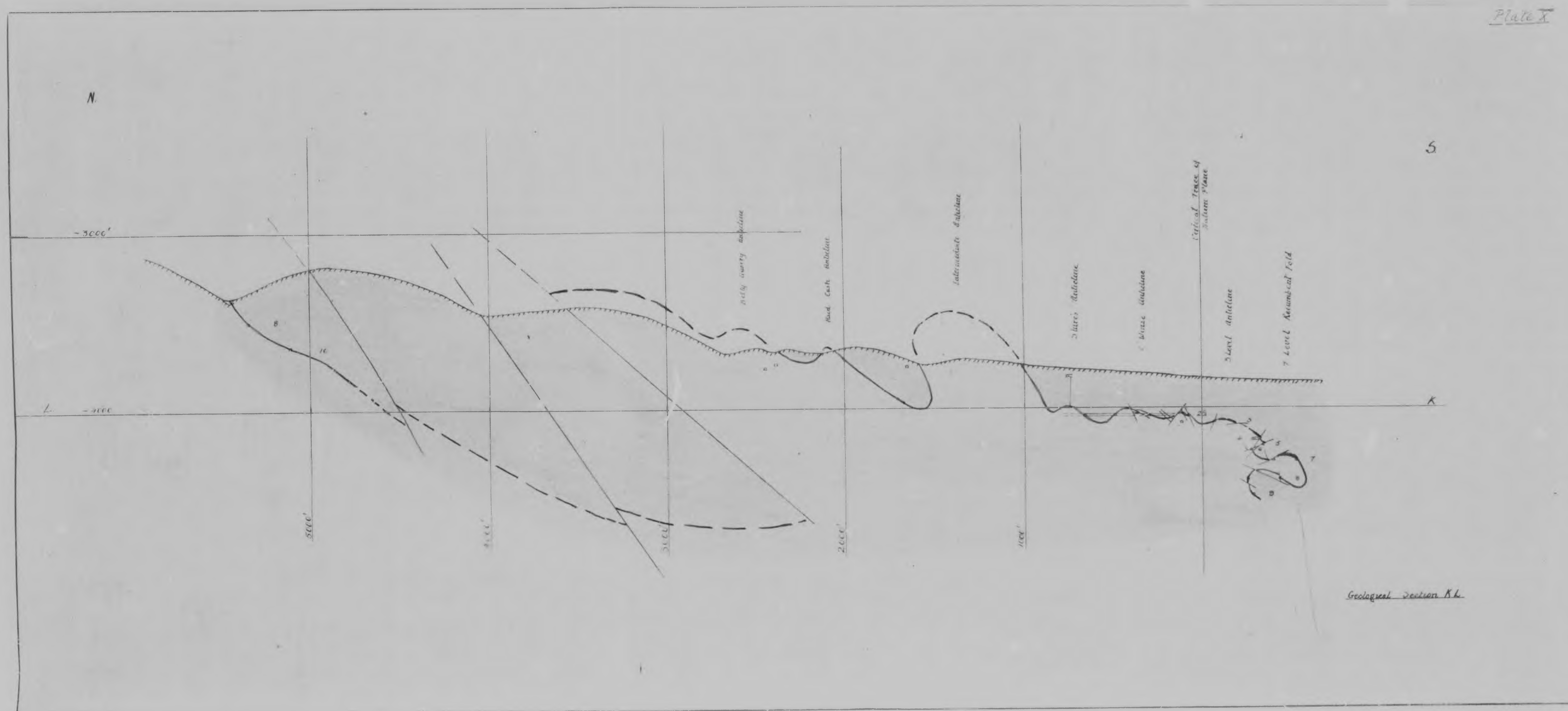
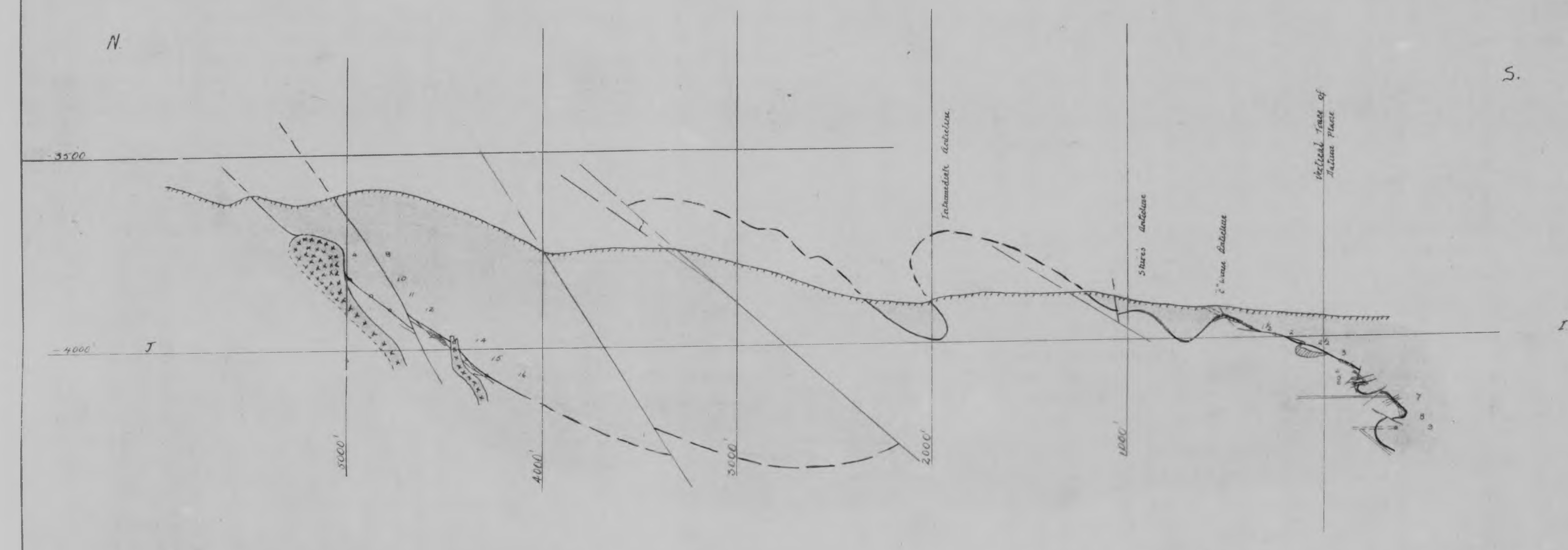


Plate X

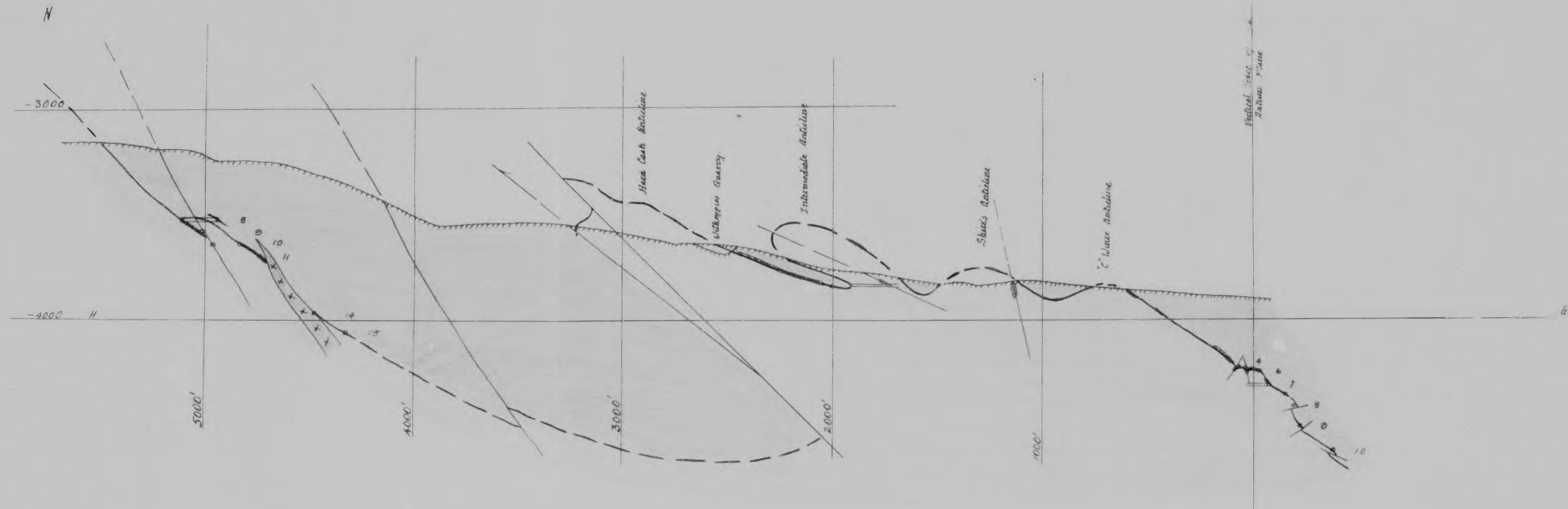


Geological Section KL

Plate IX

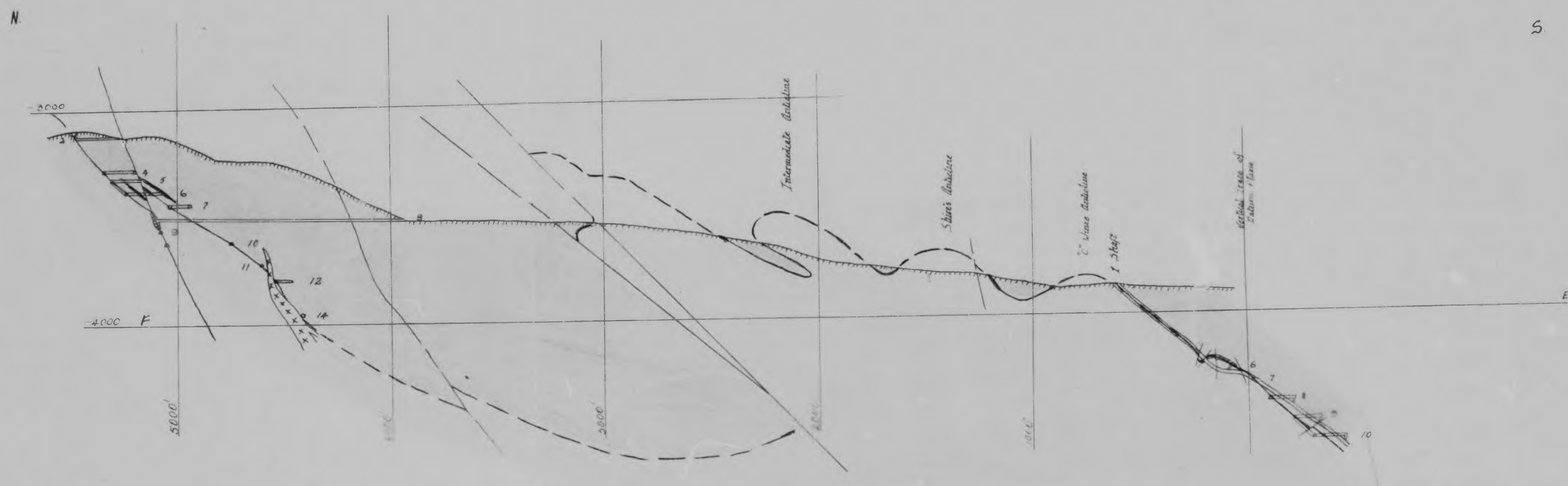


Geological Section I J



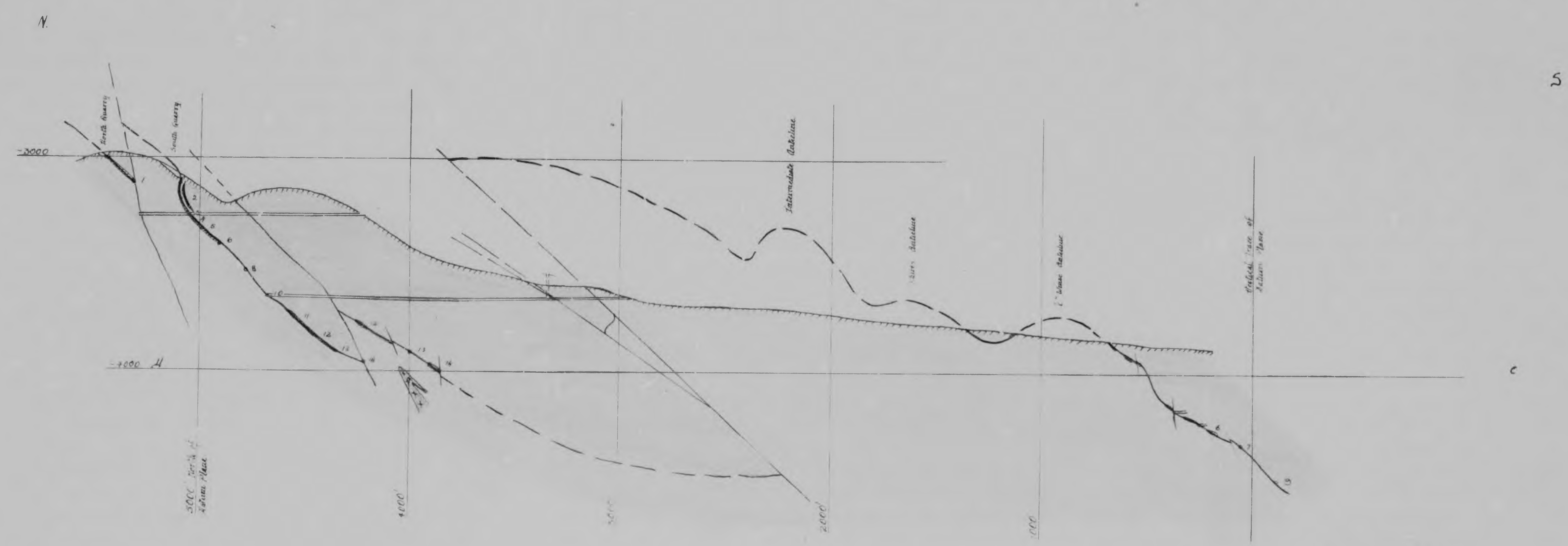
Geological Section G-H

Plate VII



Geological Section E.F.

Plate VI



Geological Section C II

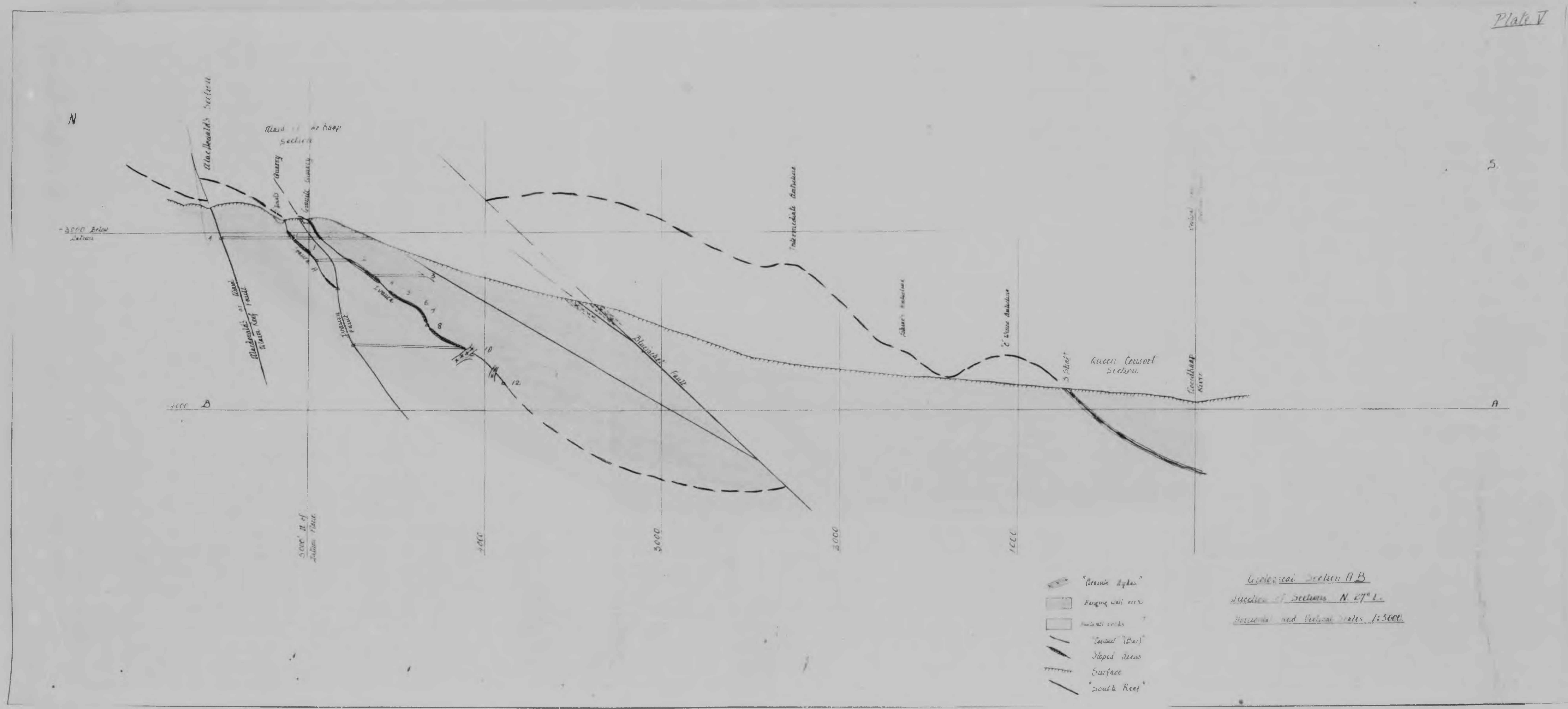


Plate V
N.
S.
MacDonald's Section
Granite Quarry
-3000' Below Datum
B
A
Macdonald's or Main Reef Fault
Ivanna Fault
Blaauwbank Fault
Intermediate Anticline
C Vaal Anticline
3 Shaft
Crocodile River
4000
3000
2000
1000
"Granite Dykes"
Hanging wall rocks
Footwall rocks
"Contact" ("Bar")
Stoped areas
Surface
"South Reef"
Geological Section A B
Direction of Section N. 27° E.
Horizontal and Vertical Scales 1:5000


SURF GEOLOGICAL PLAN
N MINES — SHEBA SECTION
SCALE 1/2,000
LEGEND
Mine Boundary
Sheba Valley
Ulundi Bar


Waste Rock Dump
Mine Offices

Plate III
LEGEND:

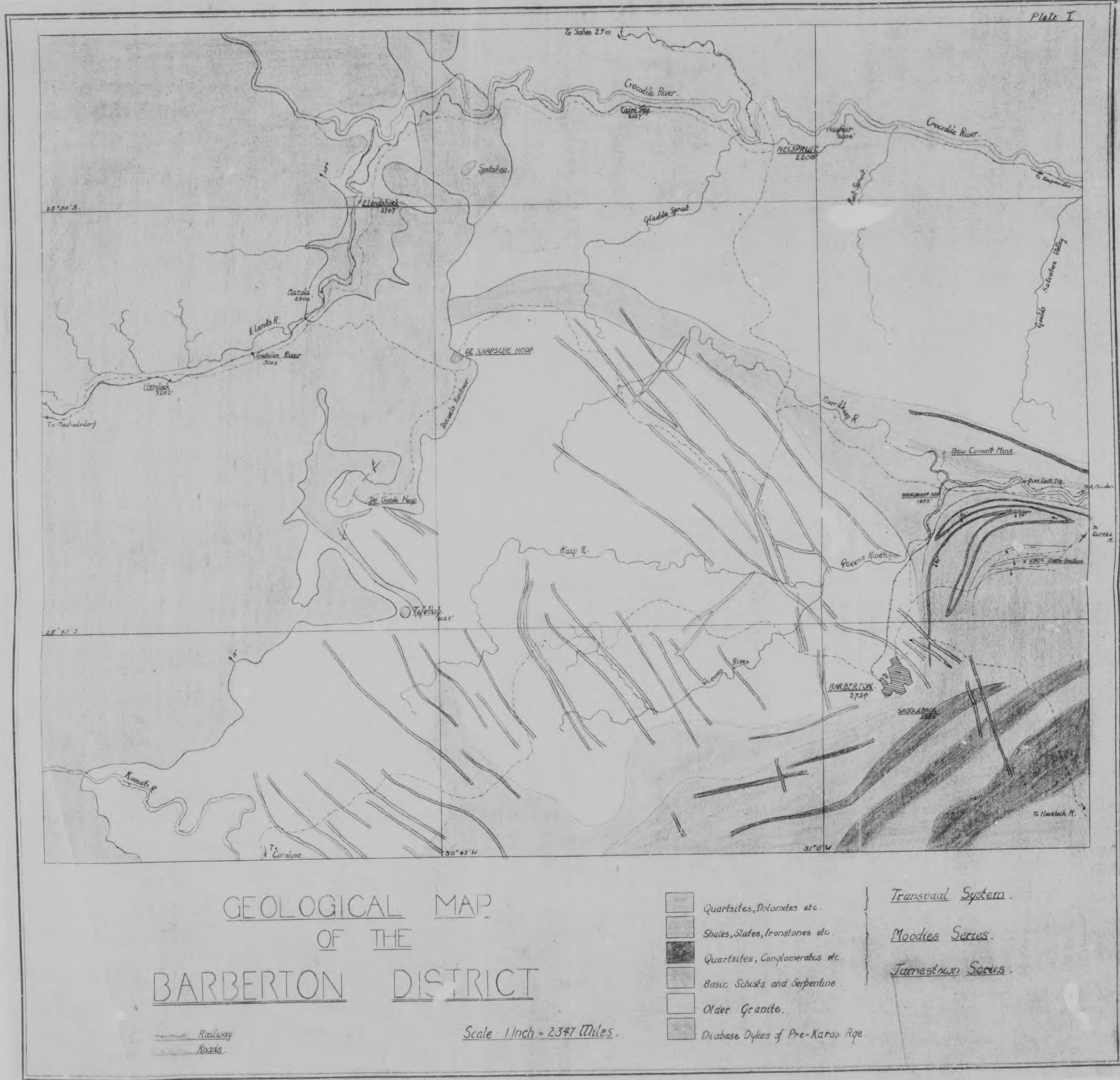


Plate I
Crocodile River.
NELSPRUIT 2206
Gladde Spruit
De Kaapsche Hoop
Elands R.
To Machadodorp
De Goede Hoop
Tafelkop
Kaap R.
Queens River
New Consort Mine
BARBERTON 2739
Komati R.
To Carolina
To Havelock M.
30°45'W
31°0'W
GEOLOGICAL MAP
OF THE
BARBERTON DISTRICT
Railway
Roads
Scale 1 Inch = 2.347 Miles.
Quartzites, Dolomites etc.
Shales, Slates, Ironstones etc.
Quartzites, Conglomerates etc.
Basic Schists and Serpentine
Older Granite.
Diabase Dykes of Pre-Karoo Age
Transvaal System.
Moodies Series.
Jamestown Series.


LEGEND: