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Ashwal, Lewis D.

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University of the Witwatersrand, Johannesburg

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(with a brief stop on Mars)

From the Earth



and back again

To the Moon

Prof. Lewis D. Ashwal
Inaugural Lecture
Wits University
25 October, 2012



15 Minutes From Manhattan There's A Place Where Even The Cops Fear To Tread.

PAUL NEWMAN in FORT APACHE, THE BRONX

The Cops Last Stand.

PAUL NEWMAN in
FORT APACHE, THE BRONX

Starring EDWARD ASNER

DANNY AIELLO, and KATHLEEN BELLER. Music by JONATHAN TUNICK

Produced by MARTIN RICHARDS and GIL CHAMPION. Written by HEYWOOD GOULD

Directed by DANIEL PETRIE




1951


1953
Money for nothin…


May 21, 1961



DeWitt Clinton High School, Bronx, N.Y.

Notable Alumni

DeWitt Clinton High School

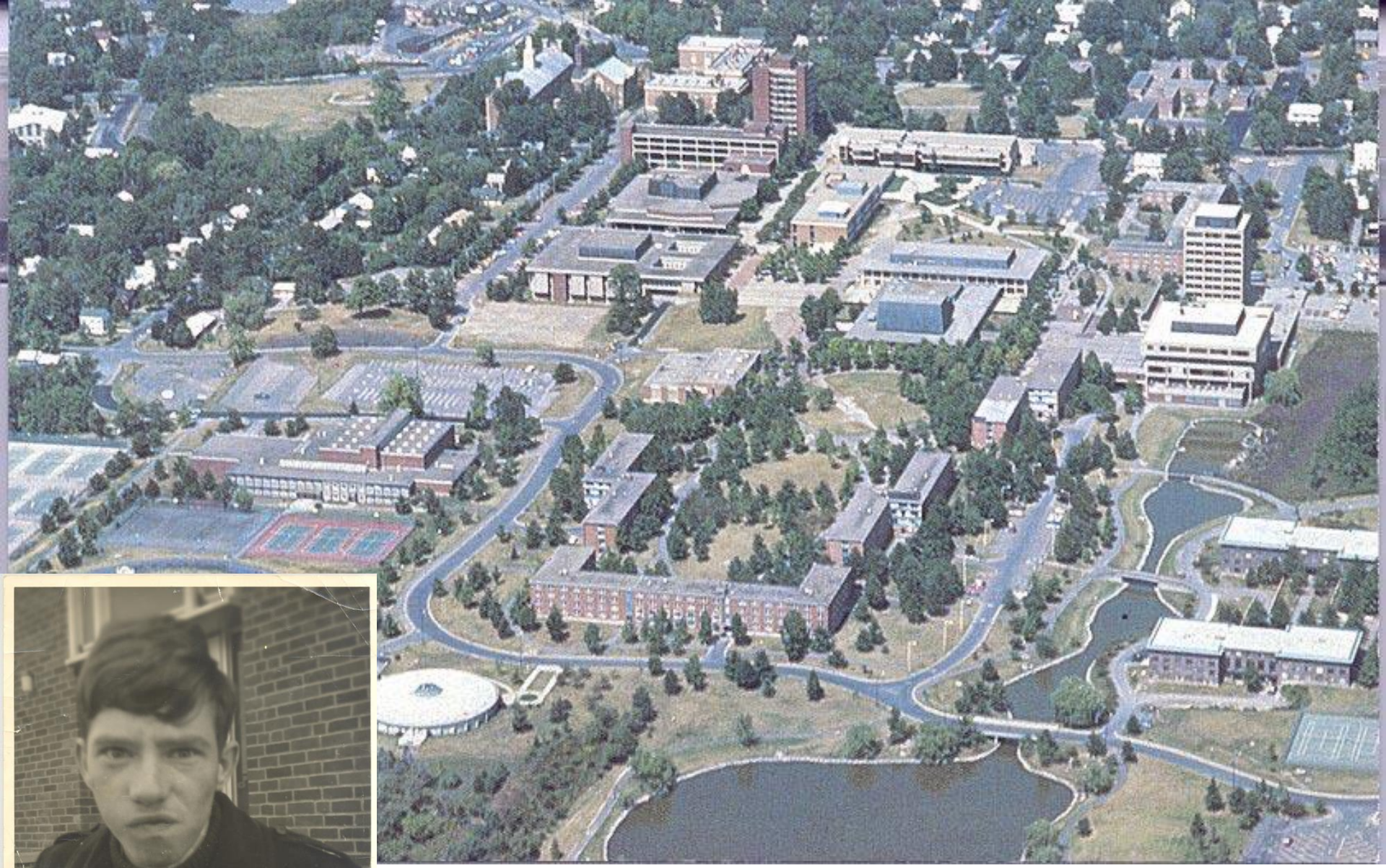
100 West Mosholu Parkway South
Bronx, NY 10468

July 2012

Created by
Gerard J. Pelisson
for the DeWitt Clinton
Alumni Association

Key on back cover

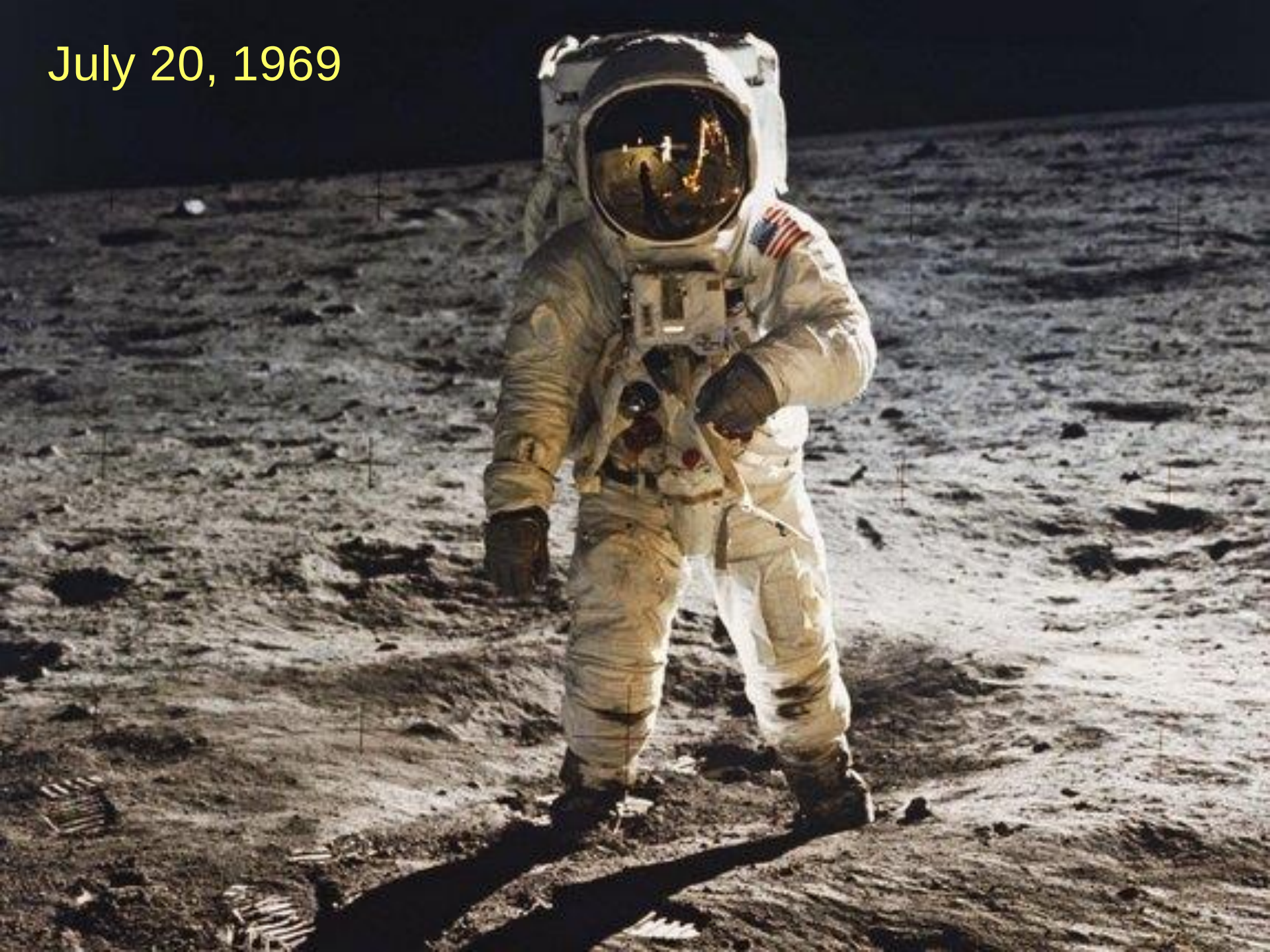




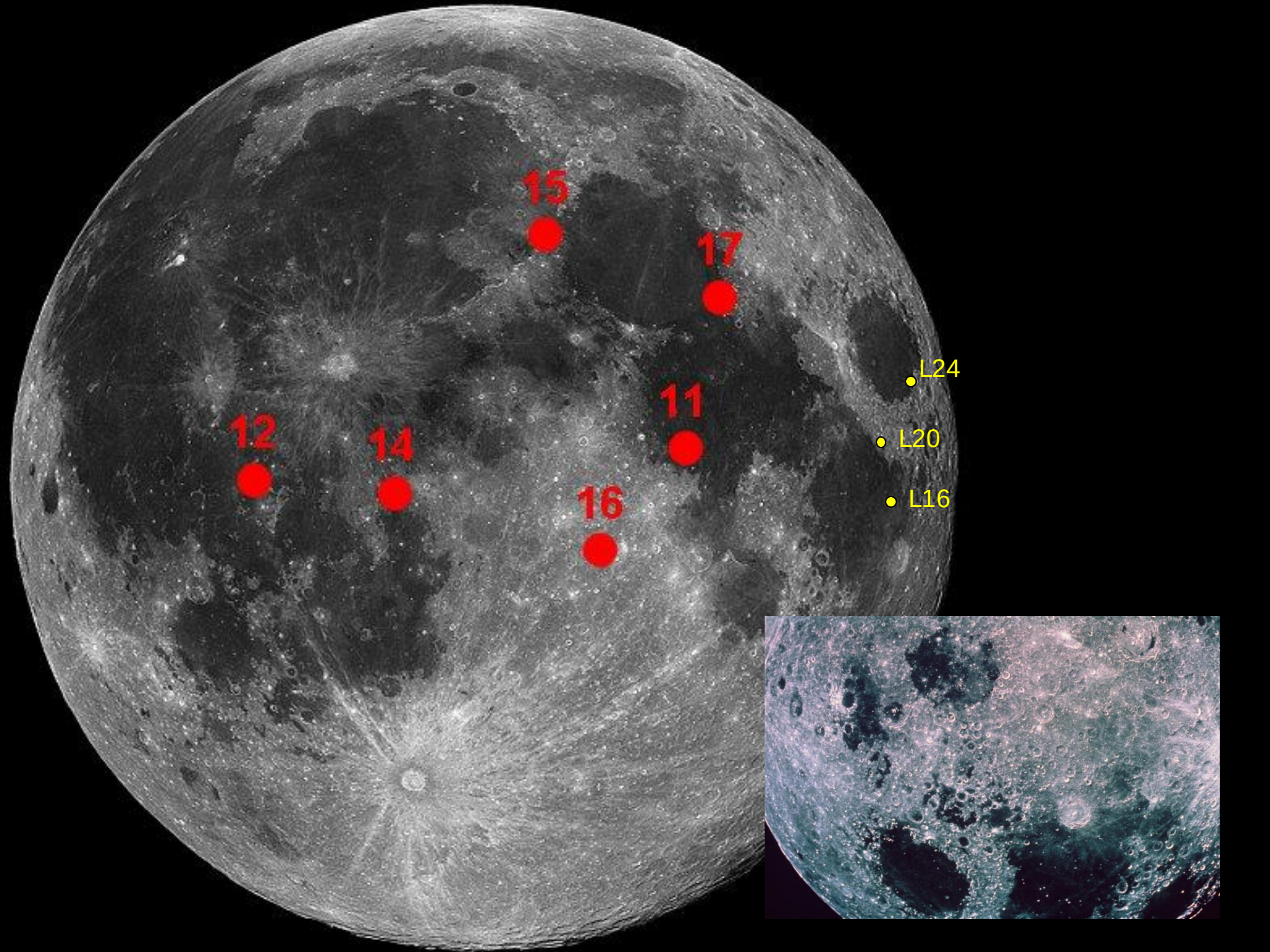
SUNY New Paltz

July 16, 1969



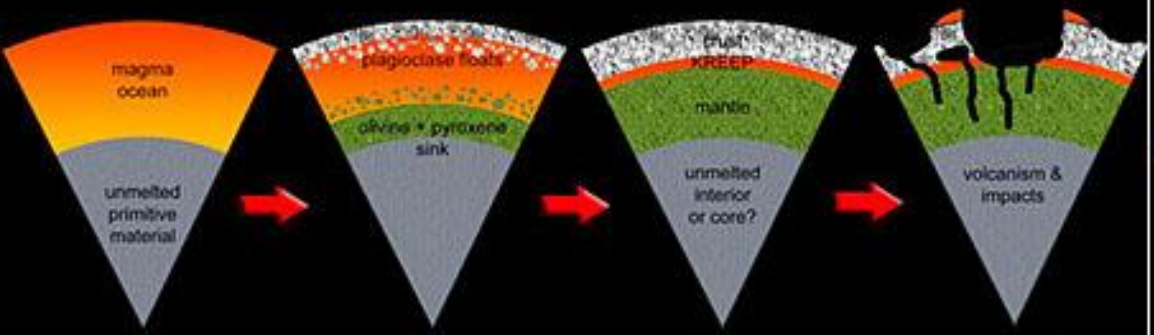

July 20, 1969


Woodstock, August 17, 1969

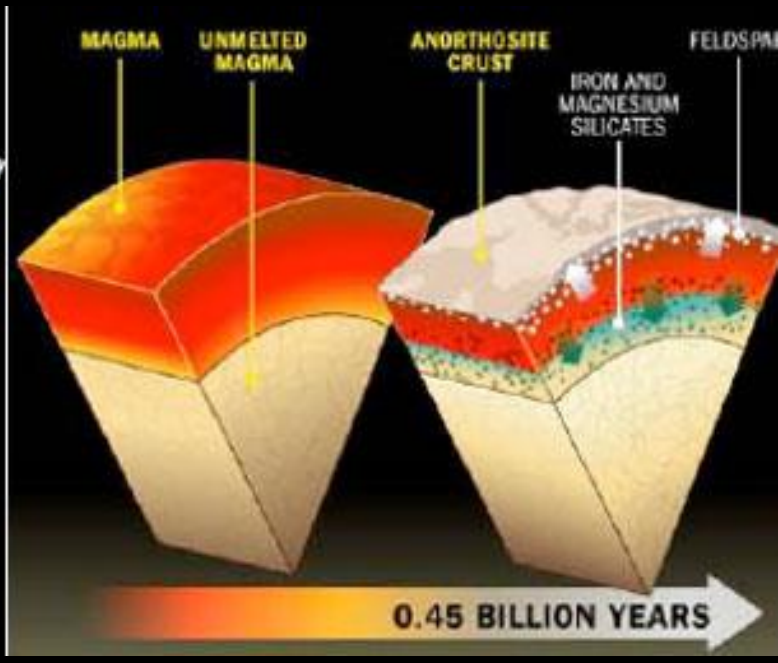

15
17
L24
11
12
14
L20
16
L16


Apollo 11
sample 10085

Magma Ocean Evolution

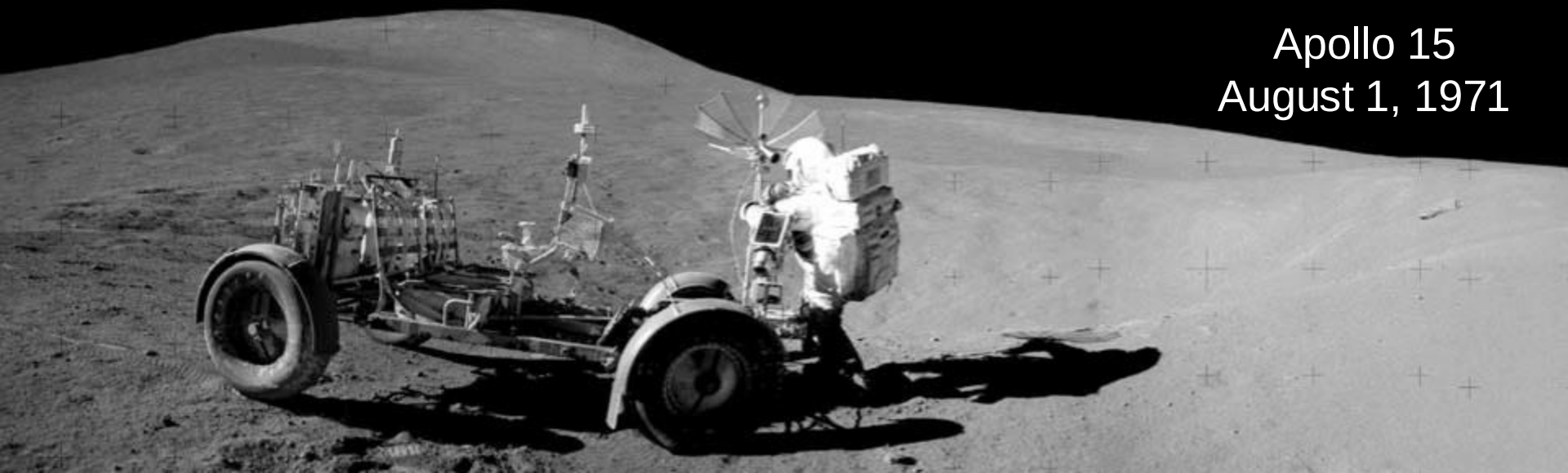


Result of hot accretion
Light minerals floated
Dense minerals sank
Whole mantle / partial mantle convection









Apollo 15
August 1, 1971



B.Sc. Graduation, 1971



Viet Nam, 1971

UMass



Peter Robinson



Tony Morse

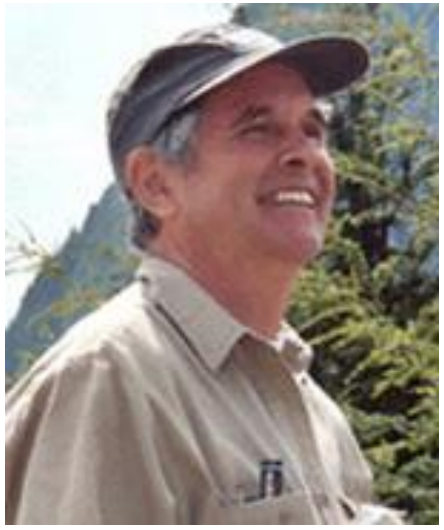


Steve Haggerty

Princeton



Rob Hargraves



Linc Hollister



Tom Jordan



McCosh Hall, Princeton University

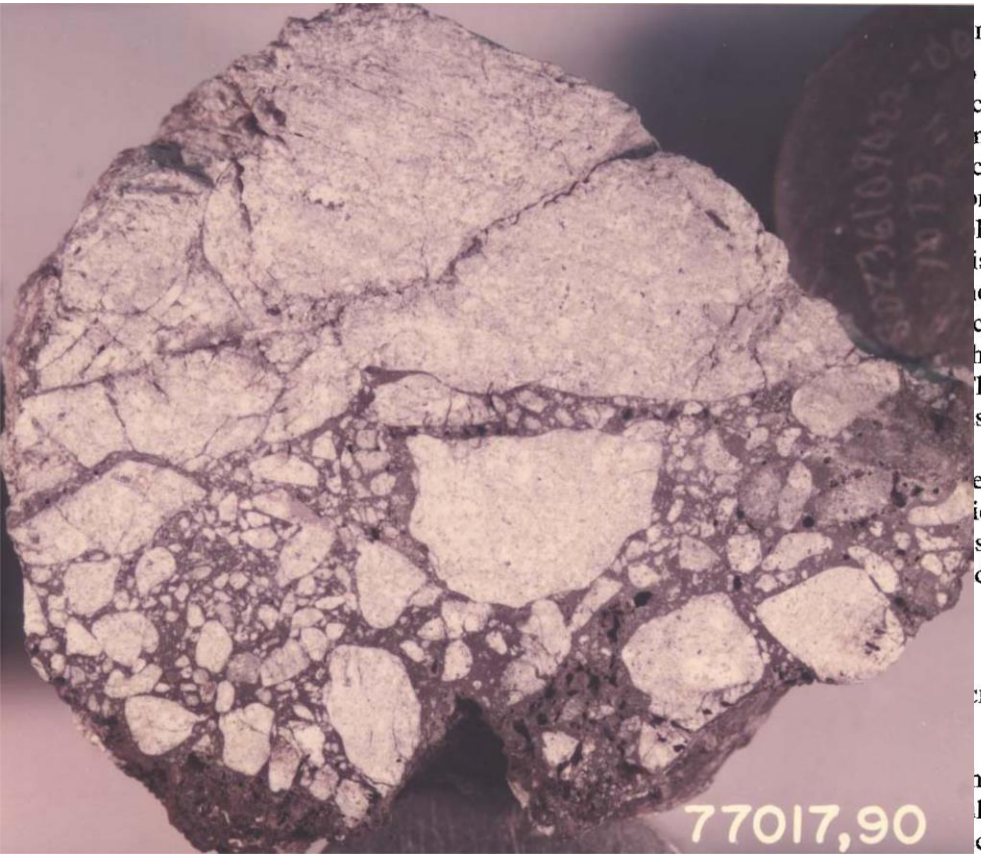
Proc. Lunar Sci. Conf. 6th (1975), p. 221–230.
Printed in the United States of America

Petrologic evidence for a plutonic igneous origin of anorthositic norite clasts in 67955 and 77017

LEWIS D. ASHWAL

Department of Geological and Geophysical Sciences, Princeton University, Princeton, N.J. 08540

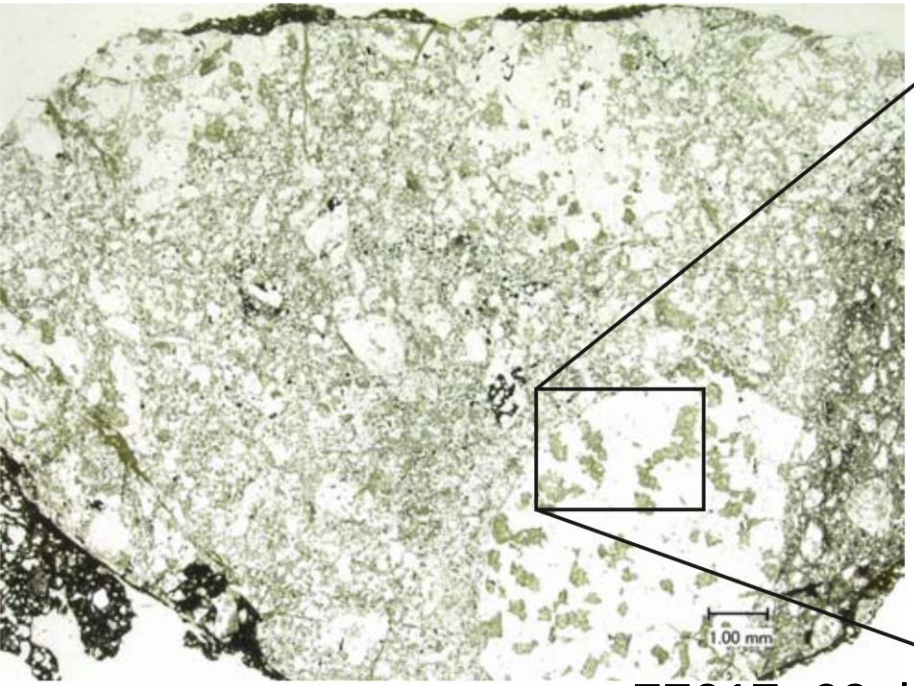
Abstract—Clasts of anorthositic norite in 67955 and 77017, and several other samples, are suggested to represent material which crystallized from a silicate magma in a plutonic environment. Although no statement can be made regarding the ultimate origin of the parent melt, its composition was relatively felsic, starting within the primary field of crystallization of either plagioclase or spinel. The sequence of crystallization was: plagioclase (and/or spinel)—olivine—low-Ca pyroxene—high-Ca pyroxene.

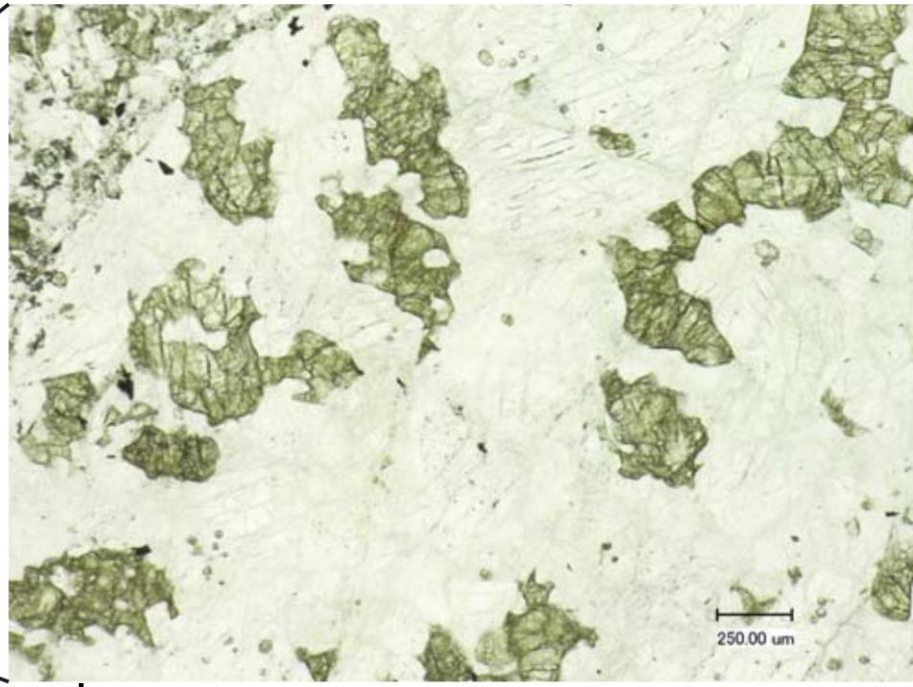


DUCTION

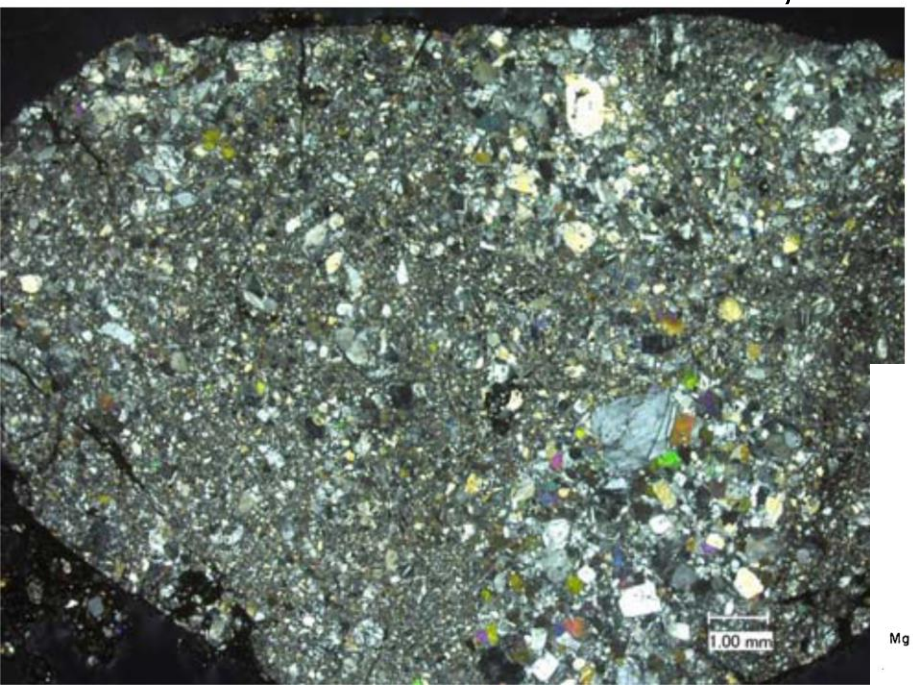
the conclusion that large-scale melting
crustal development. However, among the

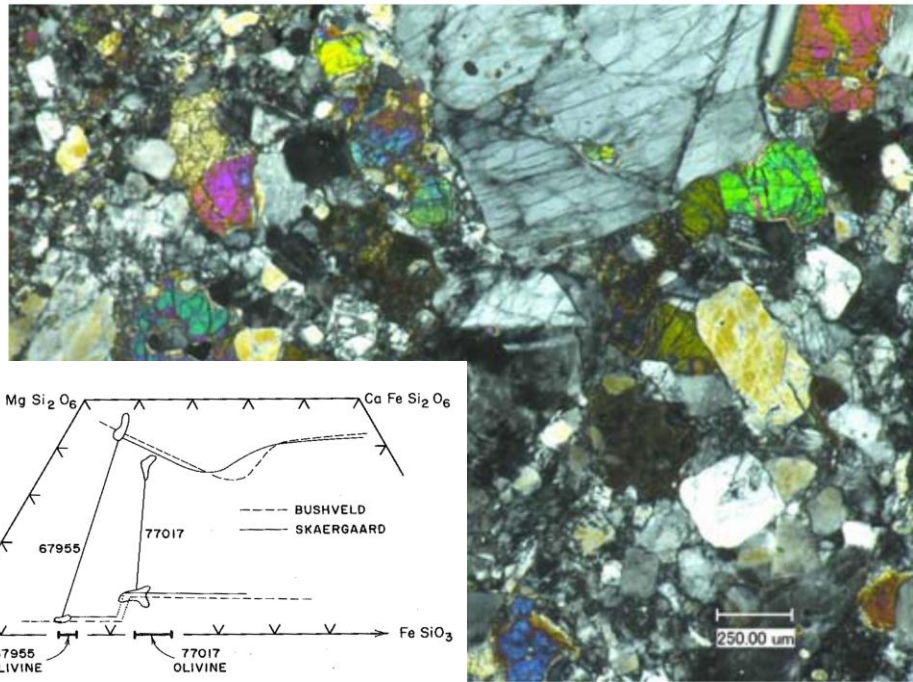






77017, 69 thin section

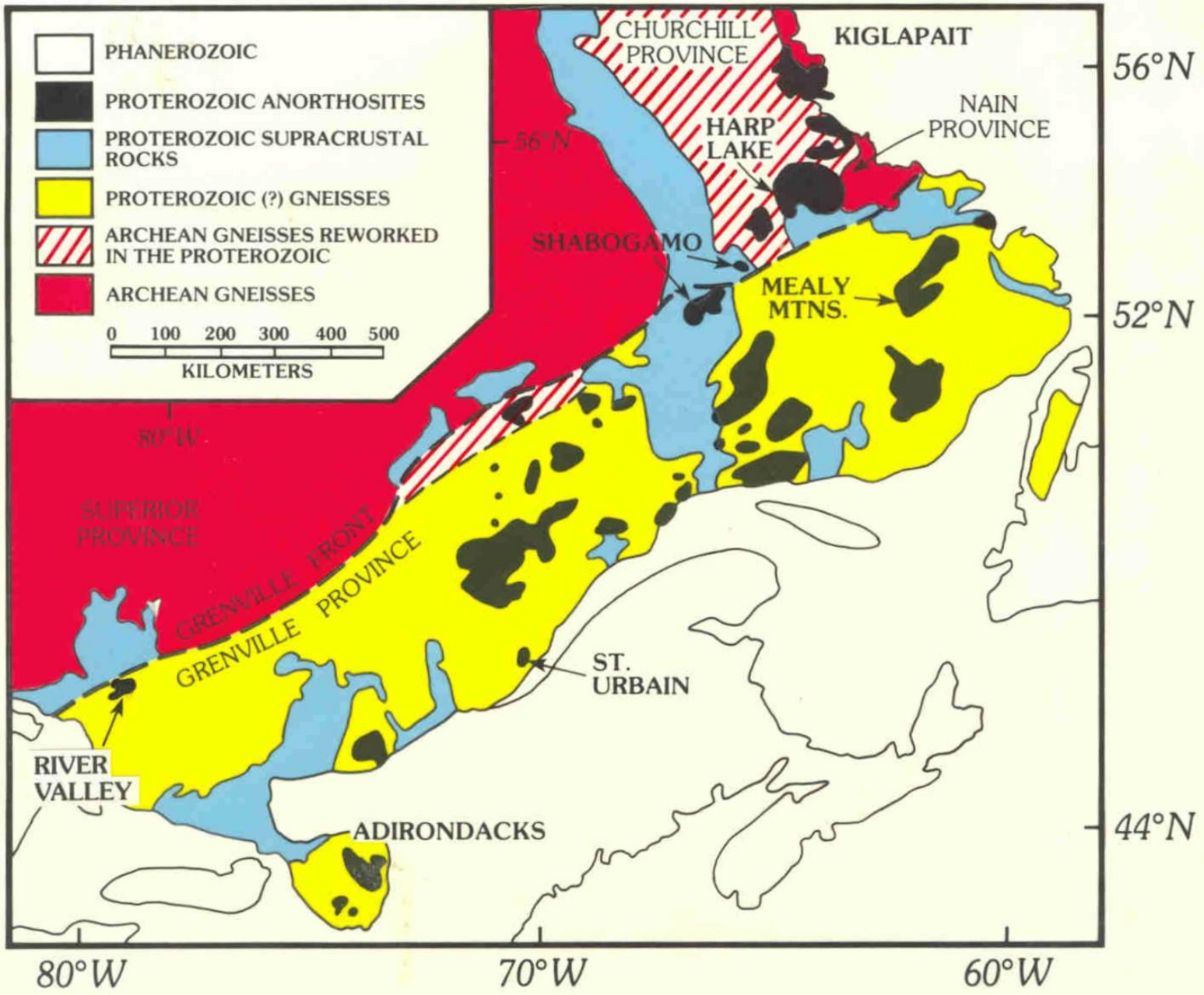





Marcy anorthosite massif
Adirondacks, New York


Lake Placid, N.Y.


Saranac Lake, N.Y.


PHANEROZOIC
PROTEROZOIC ANORTHOSITES
PROTEROZOIC SUPRACRUSTAL ROCKS
PROTEROZOIC (?) GNEISSES
ARCHEAN GNEISSES REWORKED IN THE PROTEROZOIC
ARCHEAN GNEISSES
0 100 200 300 400 500
KILOMETERS
CHURCHILL PROVINCE
KIGLAPAIT
NAIN PROVINCE
HARP LAKE
SHABOGAMO
MEALY MTNS.
56°N
52°N
44°N
80°W
70°W
60°W
SUPERIOR PROVINCE
GRENVILLE FRONT
GRENVILLE PROVINCE
ST. URBAIN
RIVER VALLEY
ADIRONDACKS


WARNING-WEAR
SAFETY GOGGLES

Morin, Quebec

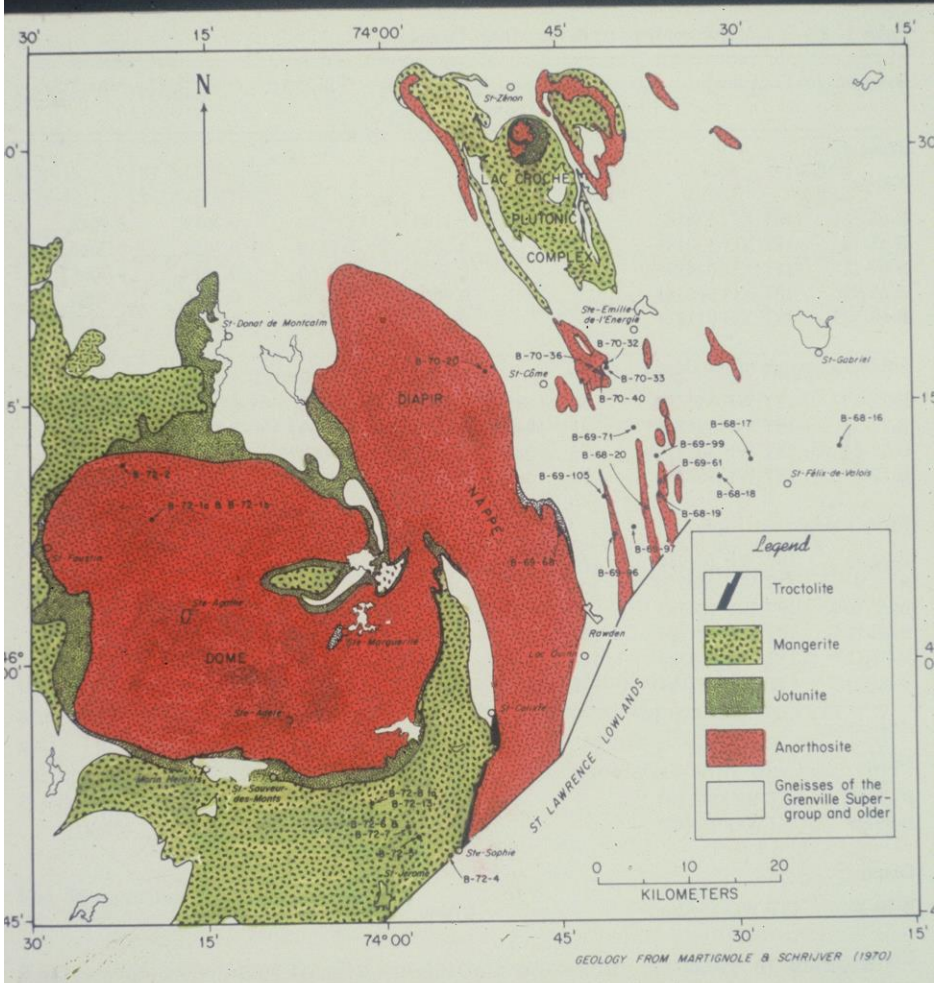
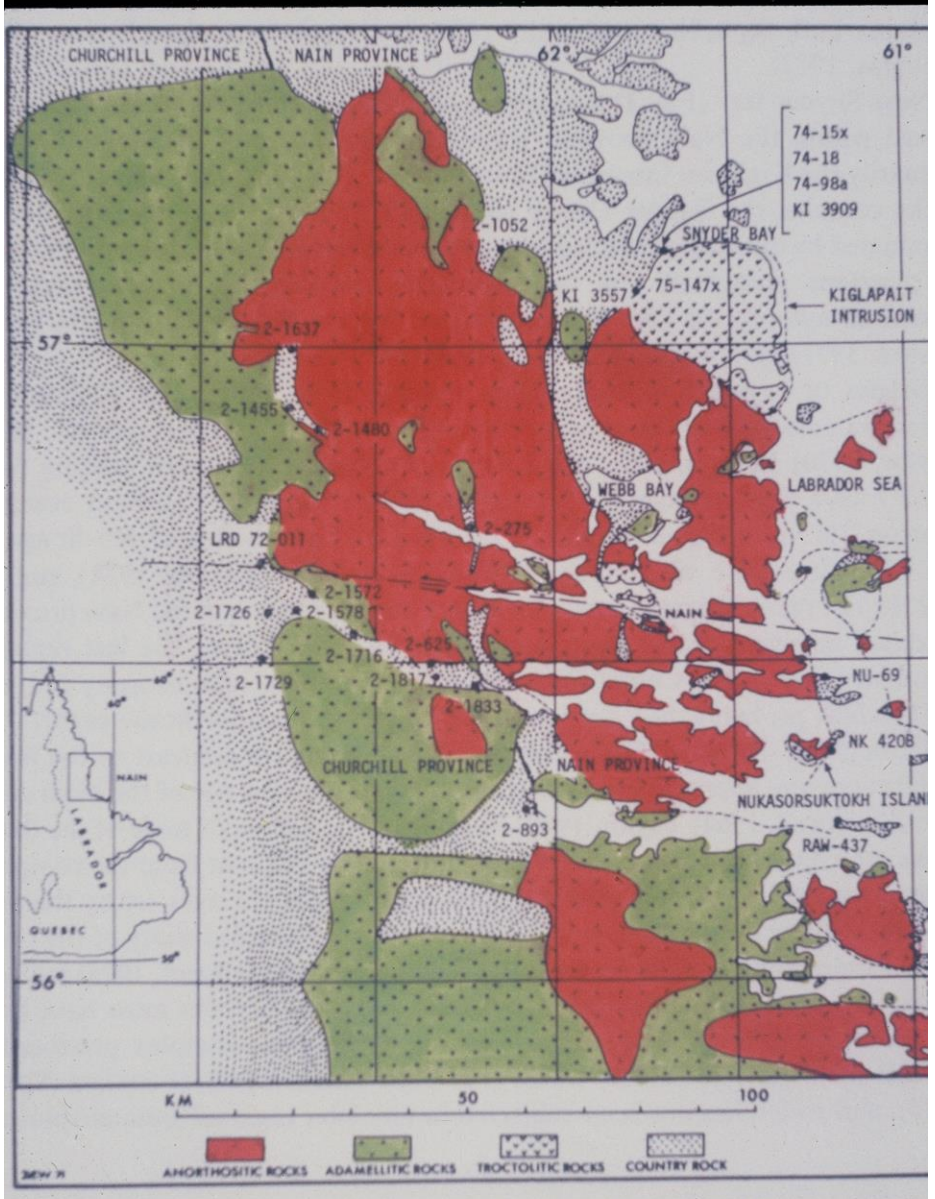
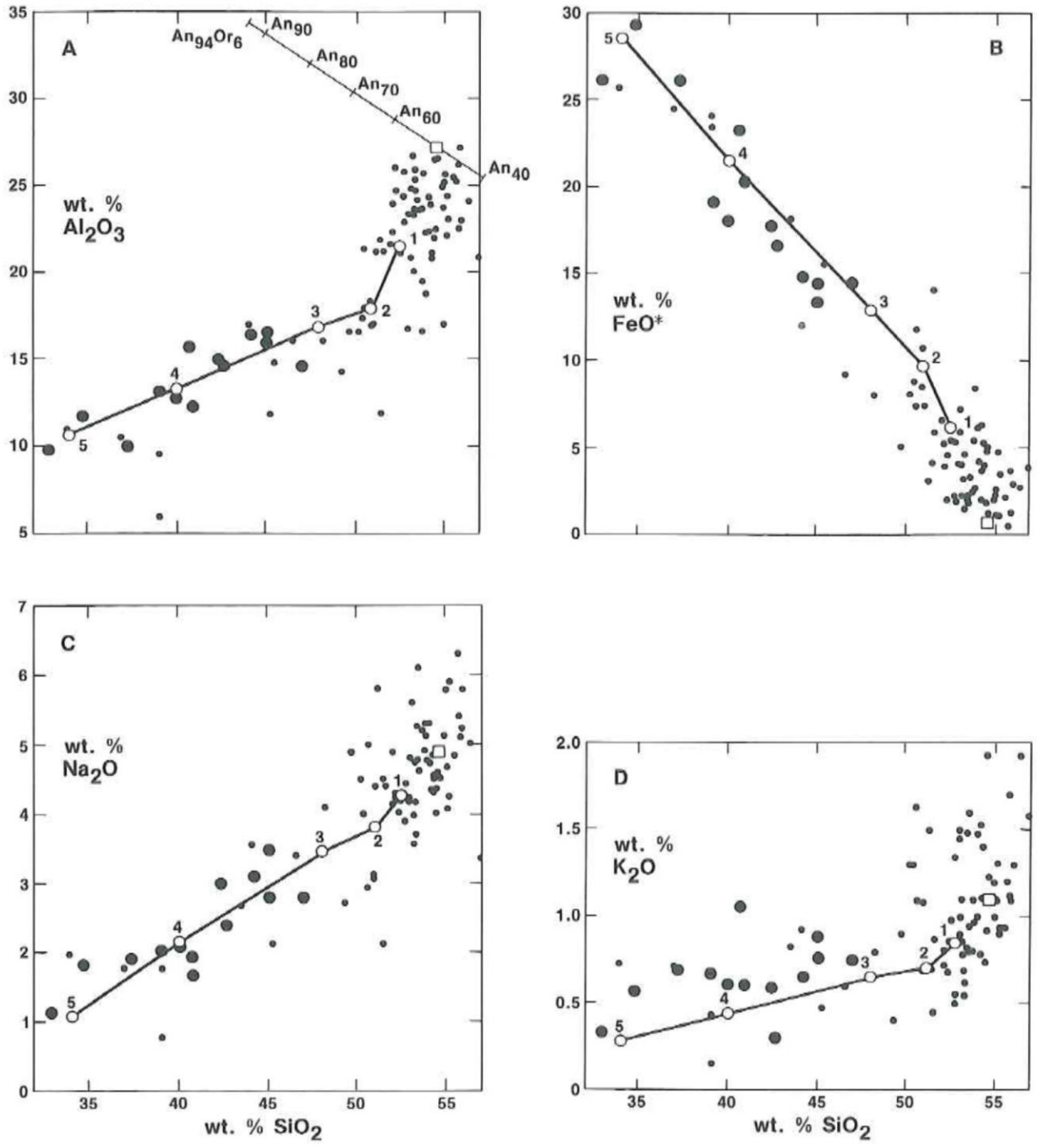


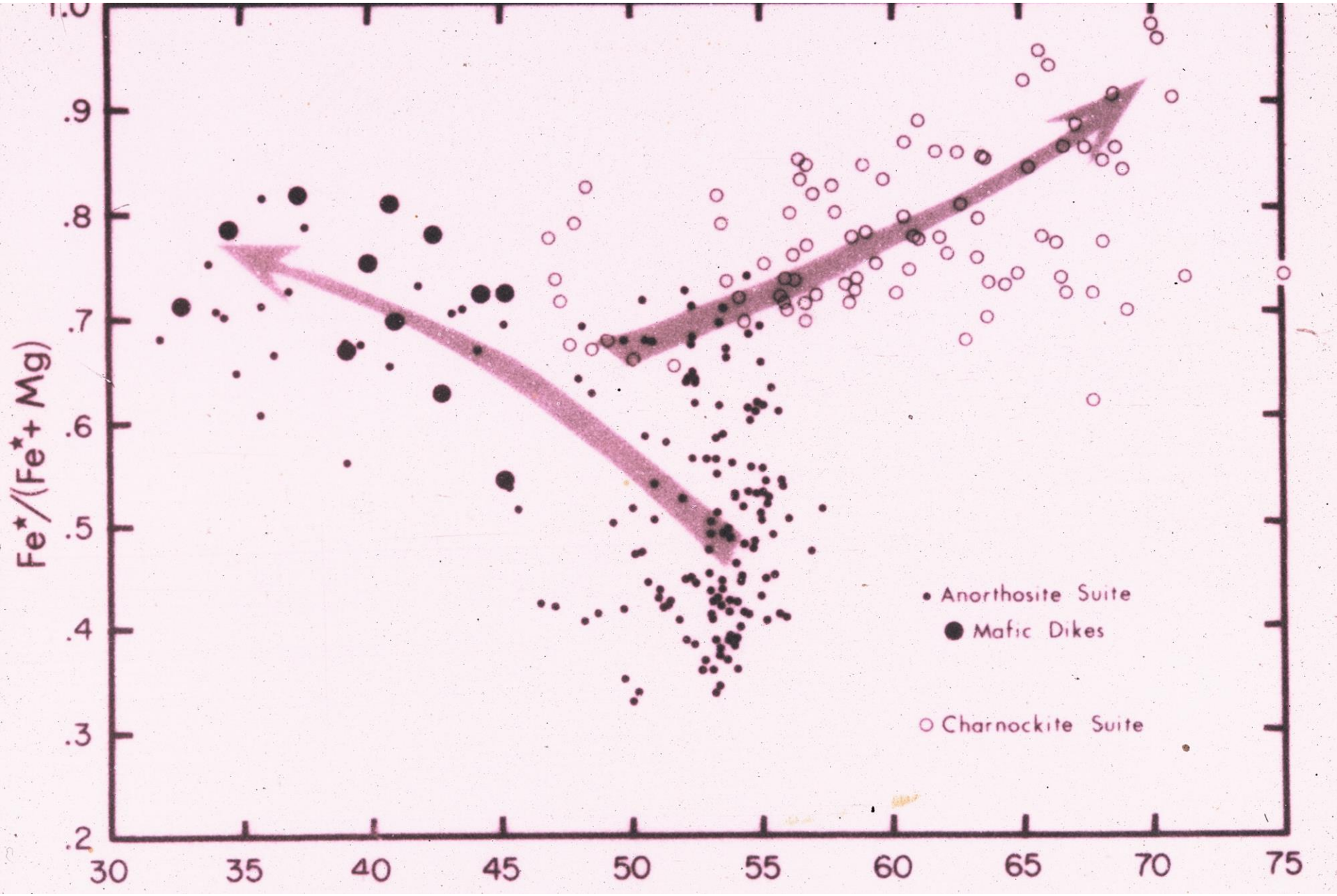
Fig. 1. Geologic map of the Morin Complex showing the sampling locations

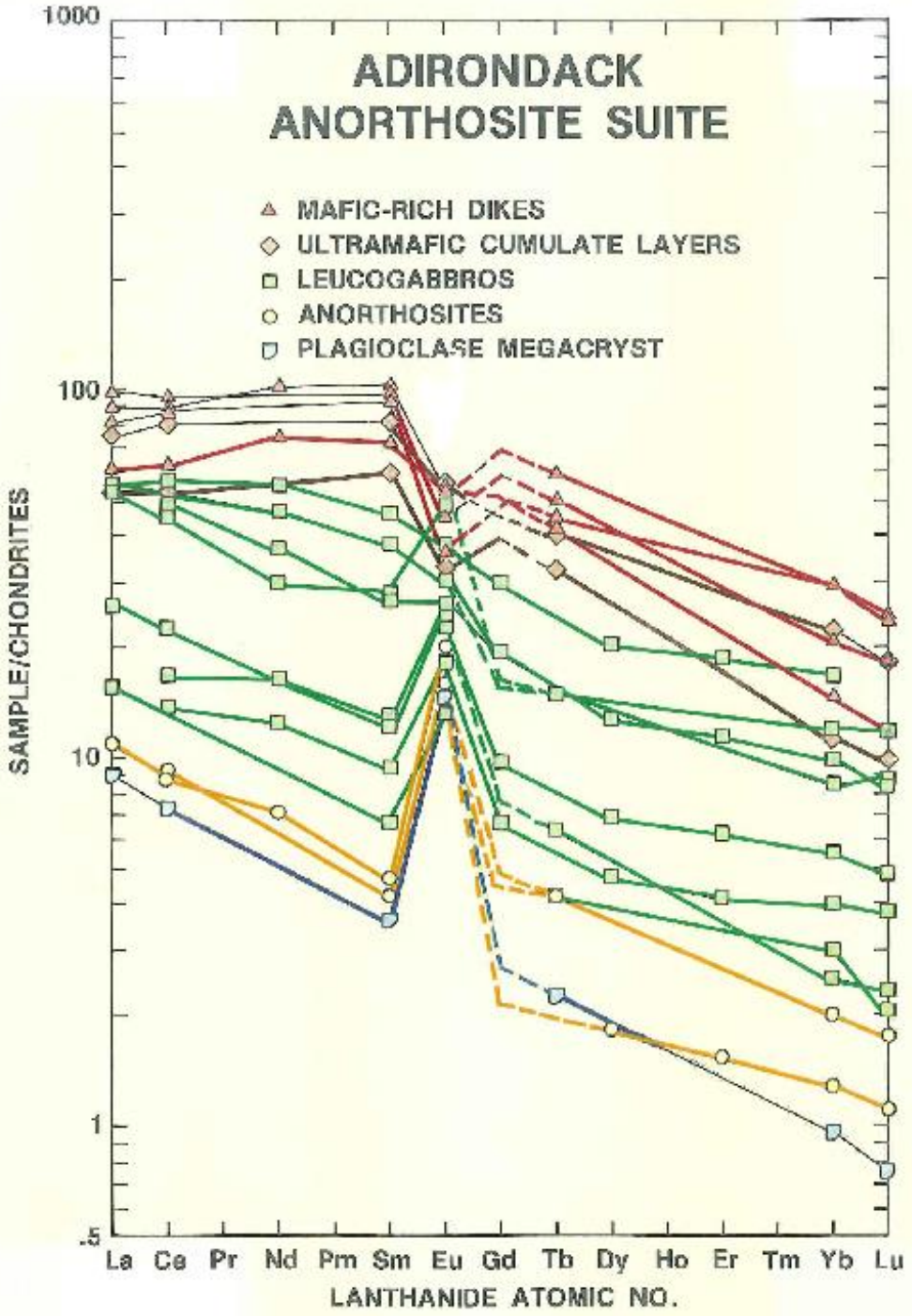
Nain, Labrador



g. 1. Geologic map of Nain complex with sample locations. Geologic base map was compile
D. deWaard based primarily on the field work of E. P. Wheeler, II.


A
$An_{94}Or_6$
An_{90}
An_{80}
An_{70}
An_{60}
An_{40}
wt. %
Al_2O_3
B
wt. %
FeO*
C
wt. %
Na_2O
wt. % SiO_2
D
wt. %
K_2O
wt. % SiO_2


Fe*/(Fe*+ Mg)
.9
.8
.7
.6
.5
.4
.3
.2
30
35
40
45
50
55
60
65
70
75
Anorthosite Suite
Mafic Dikes
Charnockite Suite
wt.% SiO2

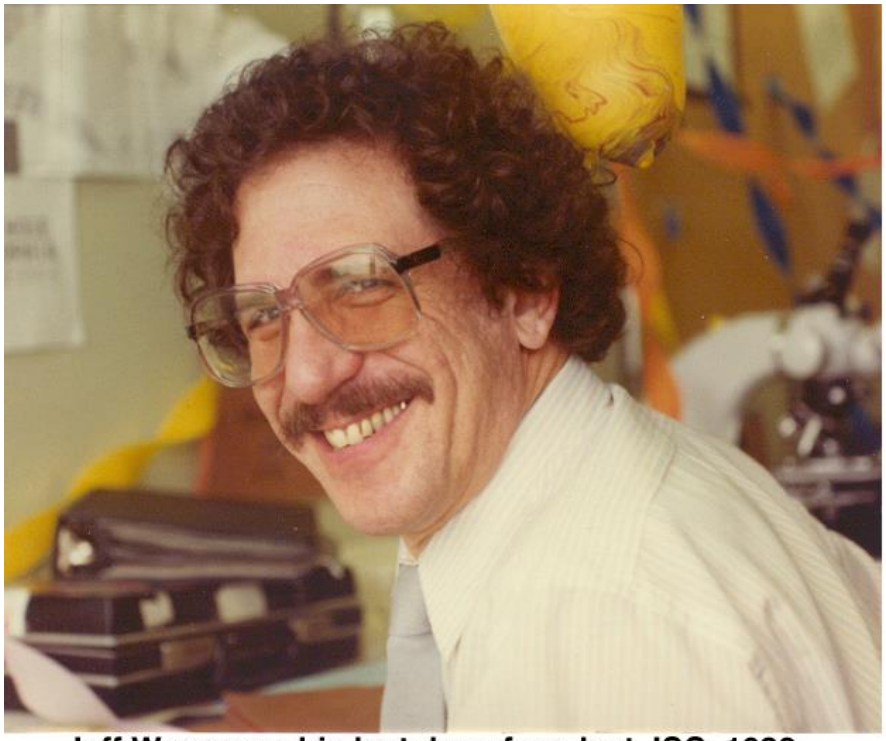

ADIRONDACK
ANORTHOSITE SUITE
MAFIC-RICH DIKES
ULTRAMAFIC CUMULATE LAYERS
LEUCOGABBROS
ANORTHOSITES
PLAGIOCLASE MEGACRYST
1000
100
10
1
.5
SAMPLE/CHONDRITES
La Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
LANTHANIDE ATOMIC NO.



Field Work, 1976



Bill Phinney, NASA JSC



Jeff Warner on his last day of work at JSC, 1982





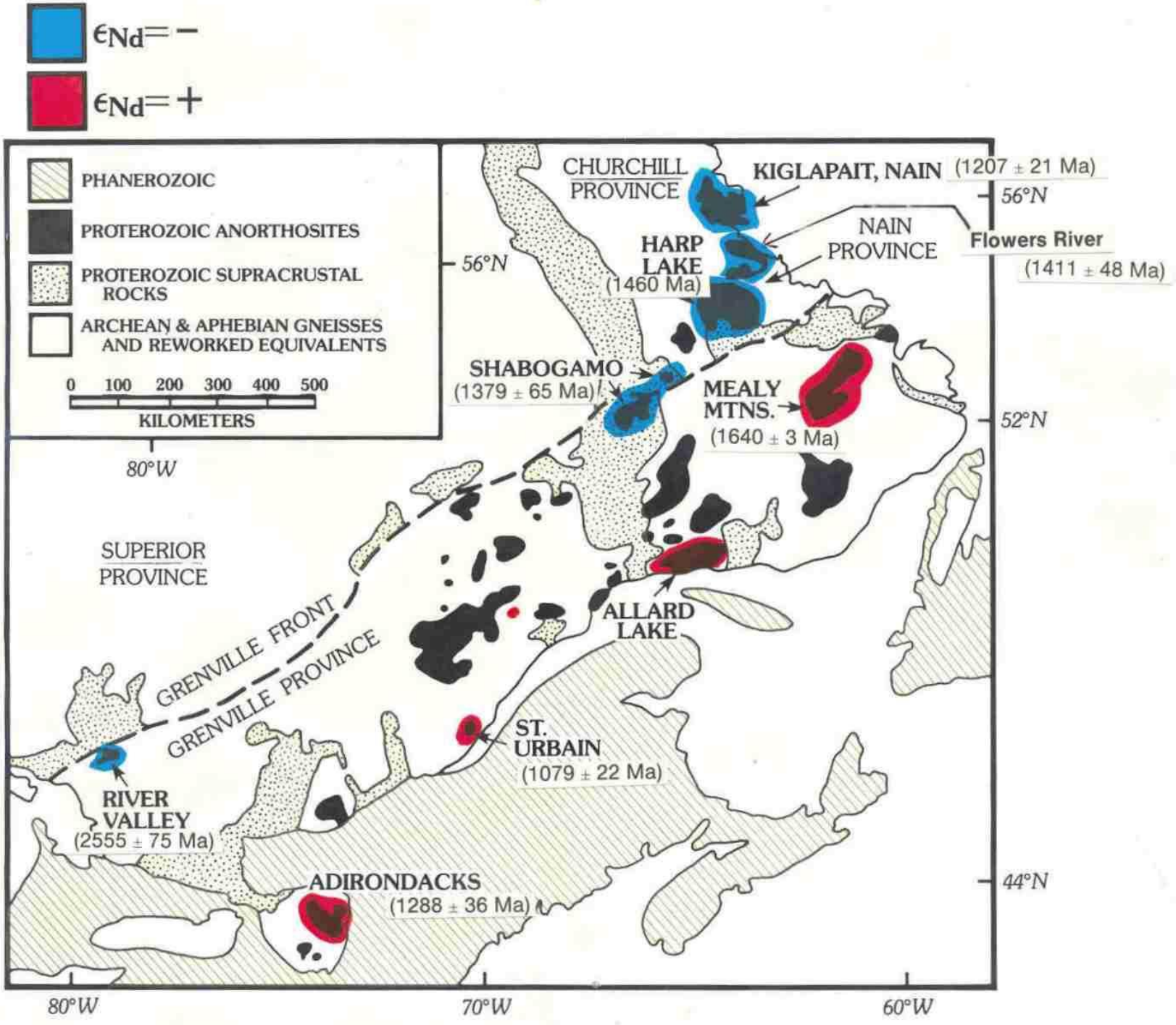
This view of the Pristine Sample Vault shows about one-third of the cabinets housed there.







Thermal ionization mass spectrometry lab
NASA Johnson Space Center, Houston


εNd = −
εNd = +
PHANEROZOIC
PROTEROZOIC ANORTHOSITES
PROTEROZOIC SUPRACRUSTAL ROCKS
ARCHEAN & APHEBIAN GNEISSES AND REWORKED EQUIVALENTS
0 100 200 300 400 500
KILOMETERS
CHURCHILL PROVINCE
KIGLAPAIT, NAIN (1207 ± 21 Ma)
NAIN PROVINCE
Flowers River (1411 ± 48 Ma)
HARP LAKE (1460 Ma)
SHABOGAMO (1379 ± 65 Ma)
MEALY MTNS. (1640 ± 3 Ma)
SUPERIOR PROVINCE
GRENVILLE FRONT
GRENVILLE PROVINCE
ALLARD LAKE
ST. URBAIN (1079 ± 22 Ma)
RIVER VALLEY (2555 ± 75 Ma)
ADIRONDACKS (1288 ± 36 Ma)
56°N
52°N
44°N
80°W
70°W
60°W

Reprinted from Nature, Vol. 306, No. 5944, pp. 679-680, 15 December 1983
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Isotopic evidence from the eastern Canadian shield for geochemical discontinuity in the Proterozoic mantle

L. D. Ashwal* & J. L. Wooden*

Lunar and Planetary Institute, 3303 NASA Road 1, Houston, Texas 77058, USA

Most workers agree that Proterozoic anorthosite massifs represent the crystallization products of mantle-derived magmas[1,2], although the composition of the parental melts is a major unsolved petrological problem[3]. As mantle-derived rocks, the massifs can be used as geochemical probes of their late Precambrian upper mantle sources. We report here Nd and Sr isotopic compositions of anorthosites and related rocks from the Grenville and Nain Provinces of the eastern Canadian shield. Here 75% of the Earth's known anorthosite is found in a 1,600-km belt from the Adirondack Mountains of northern New York State to the eastern coast of Labrador[4] (Fig. 1). The results indicate that the massifs were derived from at least two distinct mantle source regions which were established before 1,650 Myr ago, and were episodically involved in magmatism over ~500 Myr. One reservoir, below the Grenville Province, and probably below much of the eastern Superior Province, was isotopically similar to the depleted, modern-day mid-ocean ridge basalt (MORB) source. The other reservoir was chondritic to moderately enriched, and is most easily identified in the Nain Province, but may have occurred scattered throughout the Superior Province.

The anorthosites were emplaced into presumed Archaean quartzofeldspathic gneisses, although in large areas of the Grenville Province, both massifs and basement rocks were reworked during late Proterozoic (about 1,000 Myr) Grenvillian metamorphism[5]. The Adirondack anorthosite may have crystallized as much as 300 Myr before high-pressure granulite facies metamorphism[5]. The other anorthosite massifs that we analysed are unmetamorphosed and include the large (7,000–8,000 km^2) composite massifs at Harp Lake[6] and Mealy Mountains, Labrador[7], and a smaller complex (300 km^2) at St Urbain, Quebec[8] (Fig. 1). Isotopic data have been published for three mafic intrusions in Labrador: the Kiglapait layered intrusion[9–11] and the Flowers River gabbro[12], both associated with the Nain anorthosite complex, and the Shabogamo gabbro, which intrudes supracrustal rocks of the Labrador Trough on both sides of, but within 25 km of the Grenville Front[13,14] (Fig. 1).

Sr and Nd isotopic data for these anorthositic and mafic intrusions are given in Table 1. The massifs can be divided into two types based on location and Nd isotopic signature (Fig. 2). This division is possible despite uncertainties of up to 200 Myr in age and five epsilon units in initial Nd isotopic ratio (ε_{Nd} as defined in ref. 15), caused by the effects of metamorphism and crustal contamination[5]. South-east of a line roughly parallel to the Grenville Front (Fig. 1) anorthosites have positive ε_{Nd} values, implying sources with long-term depletion in light rare earth elements (LREE). To the north-west, anorthosites and mafic intrusions in Labrador have negative ε_{Nd} values that suggest derivation from LREE-enriched sources. With the

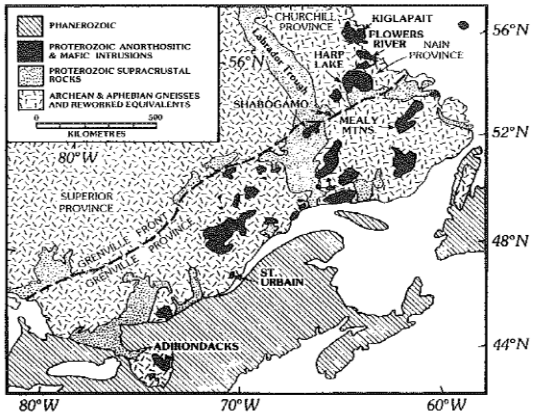


Fig. 1 Geological map of eastern North America showing locations of major Proterozoic anorthosite massifs and mafic intrusions.

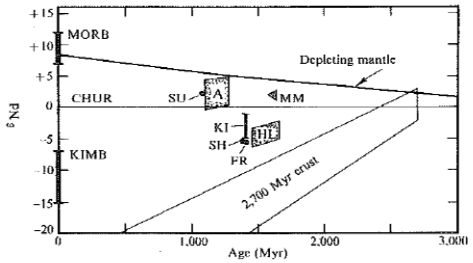


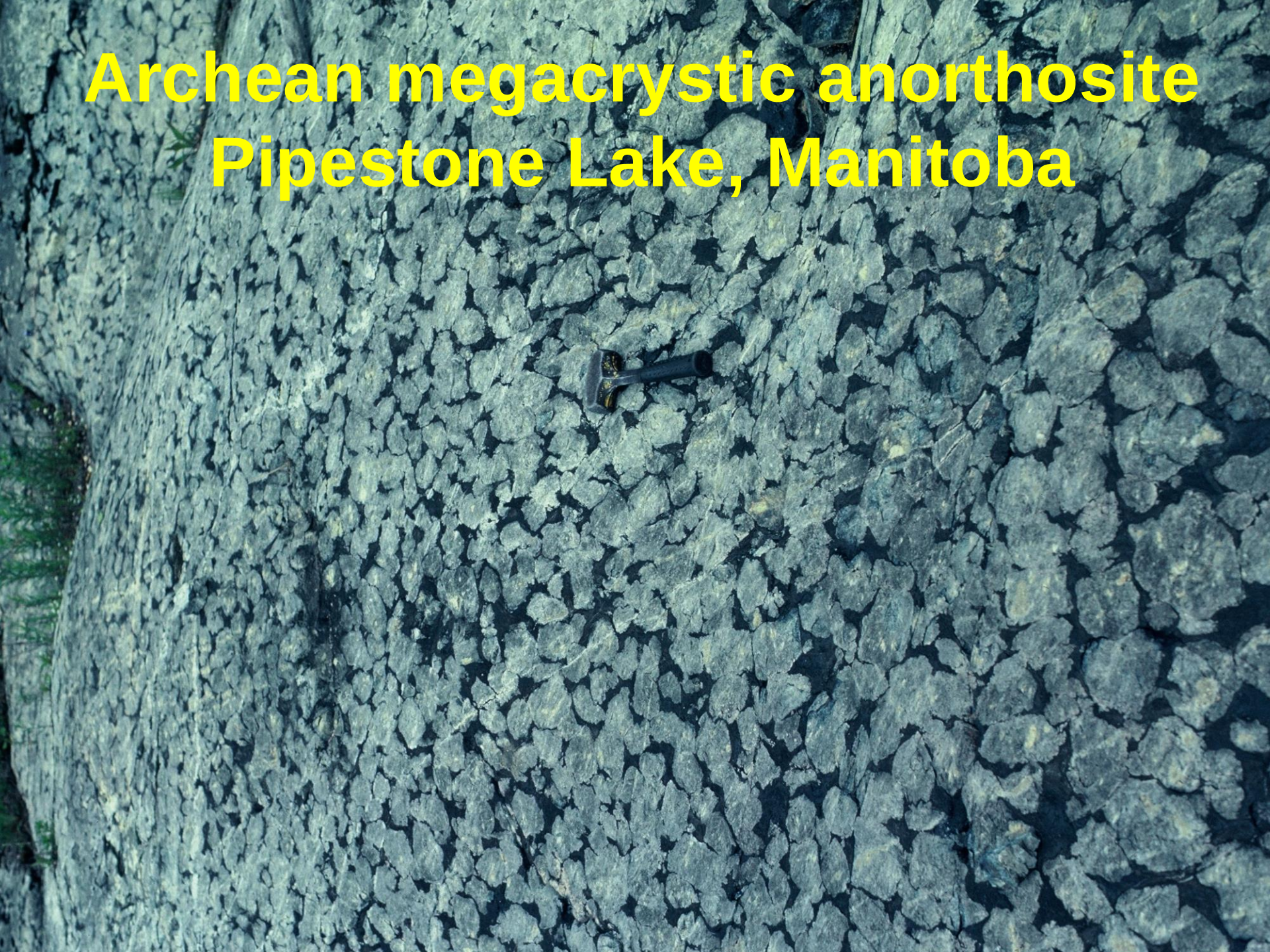
Fig. 2 Plot of age versus ε_{Nd} for Proterozoic anorthositic and mafic intrusions from the eastern Canadian shield. Massifs derived from sources with a depleted signature plot above the chondritic evolution line (CHUR), and include St Urbain (SU), Adirondacks (A) and Mealy Mountains (MM). Intrusions plotting below the CHUR line including Kiglapait (KI), Shabogamo (SH), Flowers River (FR) and Harp Lake (HL) may have been derived from enriched reservoirs. Data for some massifs are shown as polygons because of age uncertainties and contamination effects. Curve representing evolution of depleting mantle is from ref. 15; field showing evolution of 2,700-Myr silicic crust is from unpublished data of J.L.W. Ranges of ε_{Nd} for modern-day MORB[29] and Australian kimberlites (KIMB)[18] are also shown.

It must be considered plausible that the Labrador massifs north-west of the Grenville Front do not reflect the isotopic compositions of their mantle sources, but instead were affected by a 'crustal' contaminant enriched in $^{87}Sr/^{86}Sr$ and depleted in $^{143}Nd/^{144}Nd$. It has been suggested, for example, that at least 20% assimilation of a granitic component by a mantle-derived mafic melt would be required to lower the ε_{Nd} of the Shabogamo gabbro from 0 to −5.3 (ref. 13). Much larger volumes of contaminant would be required if the primary melts were originally derived from a depleted source (Fig. 2). It is not clear

NASA-S-80-10168

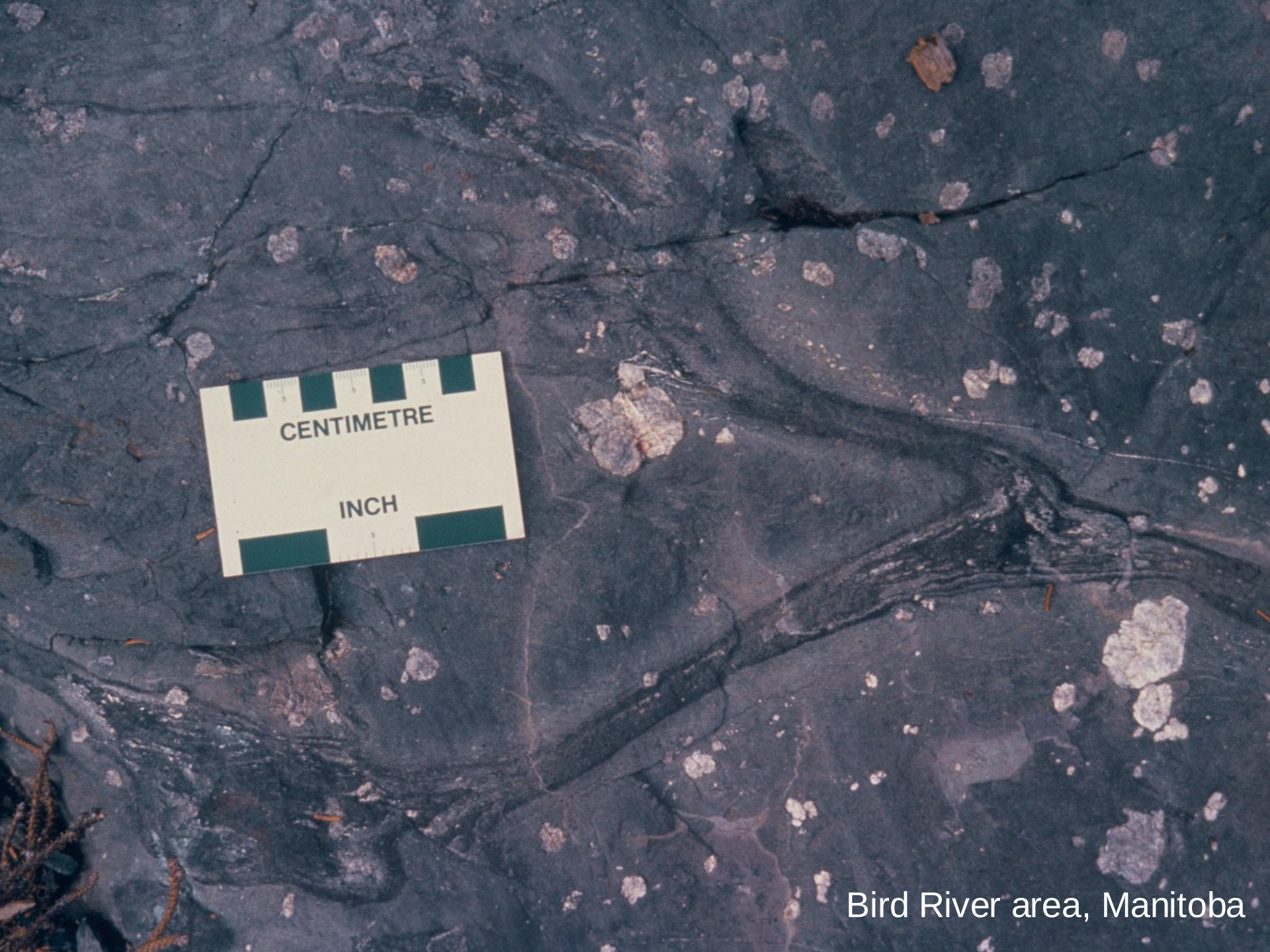
GENERALIZED GEOLOGIC MAP OF SUPERIOR PROVINCE



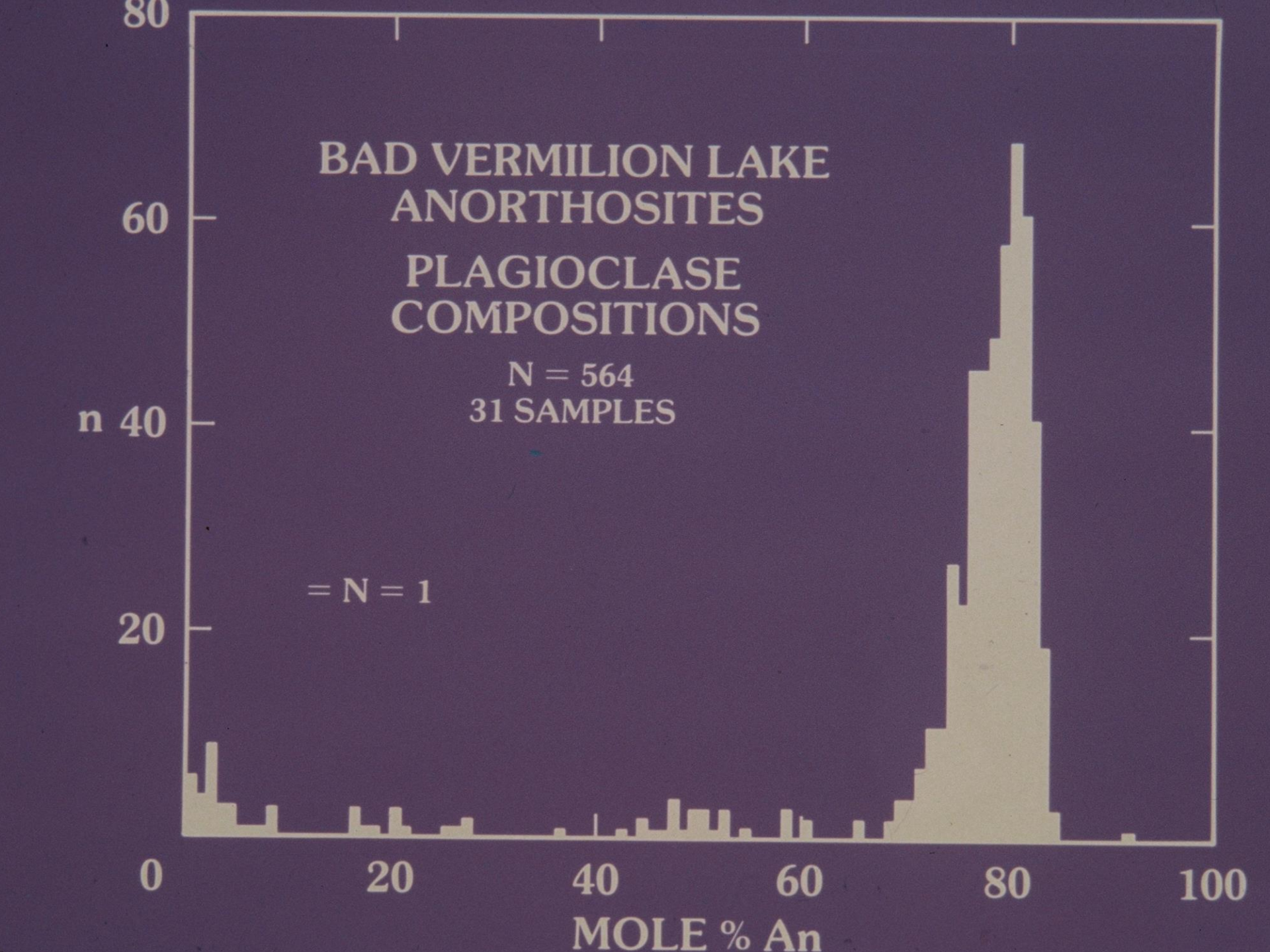

Archean megacrystic anorthosite
Pipestone Lake, Manitoba



Bird River Sill, Manitoba



Bird River area, Manitoba


BAD VERMILION LAKE
ANORTHOSITES
PLAGIOCLASE
COMPOSITIONS
N = 564
31 SAMPLES
= N = 1
n
80
60
40
20
0
20
40
60
80
100
MOLE % An



Meteorites from Mars?

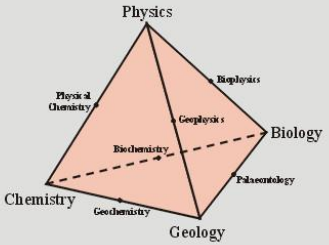
Advice to young scientists:

-Move off the corners of the tetrahedron

-Make measurements where no one has made them before

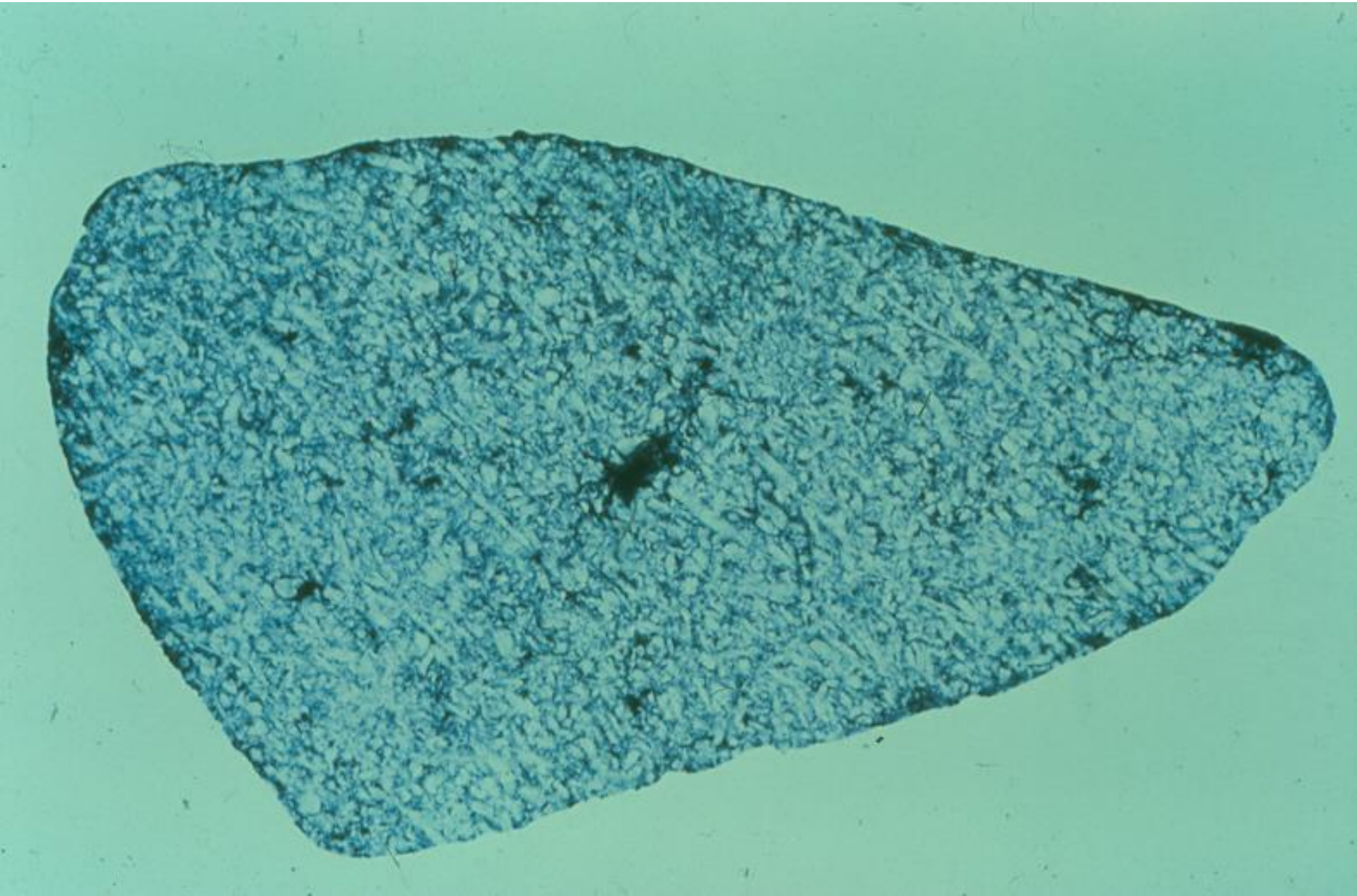
-Don't forget the scientific method

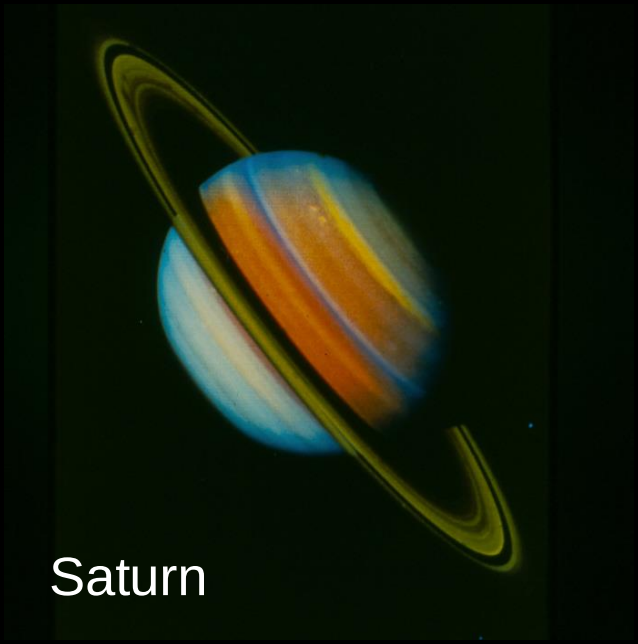
-- Observation
--Hypothesis
--Test hypothesis
--Refine hypothesis



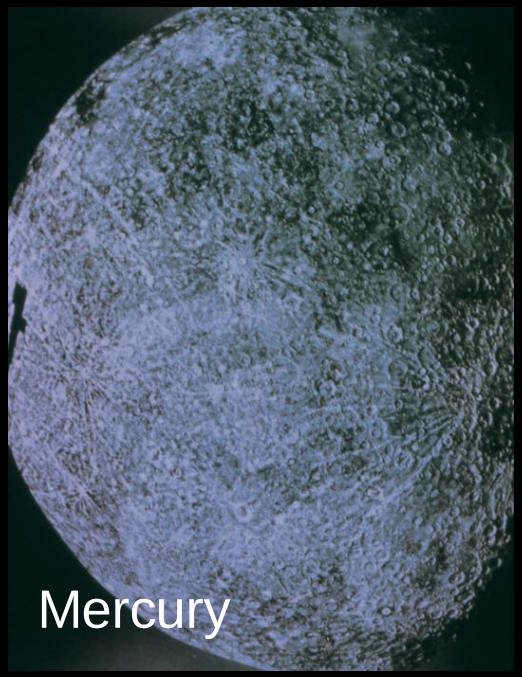


Shergotty meteorite, India (Mars)




Saturn


Ganymede


Mercury

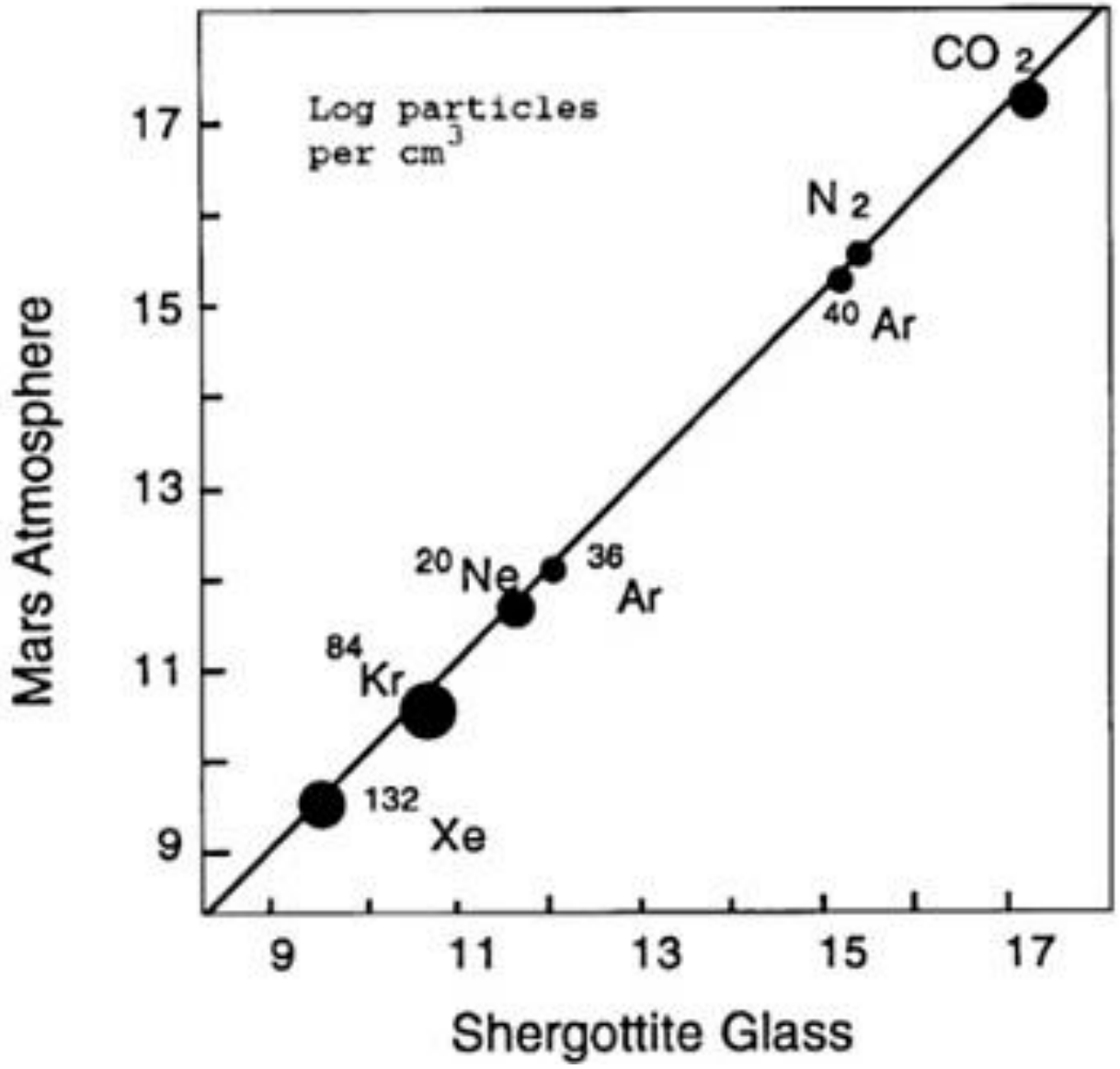

Venus

Mars



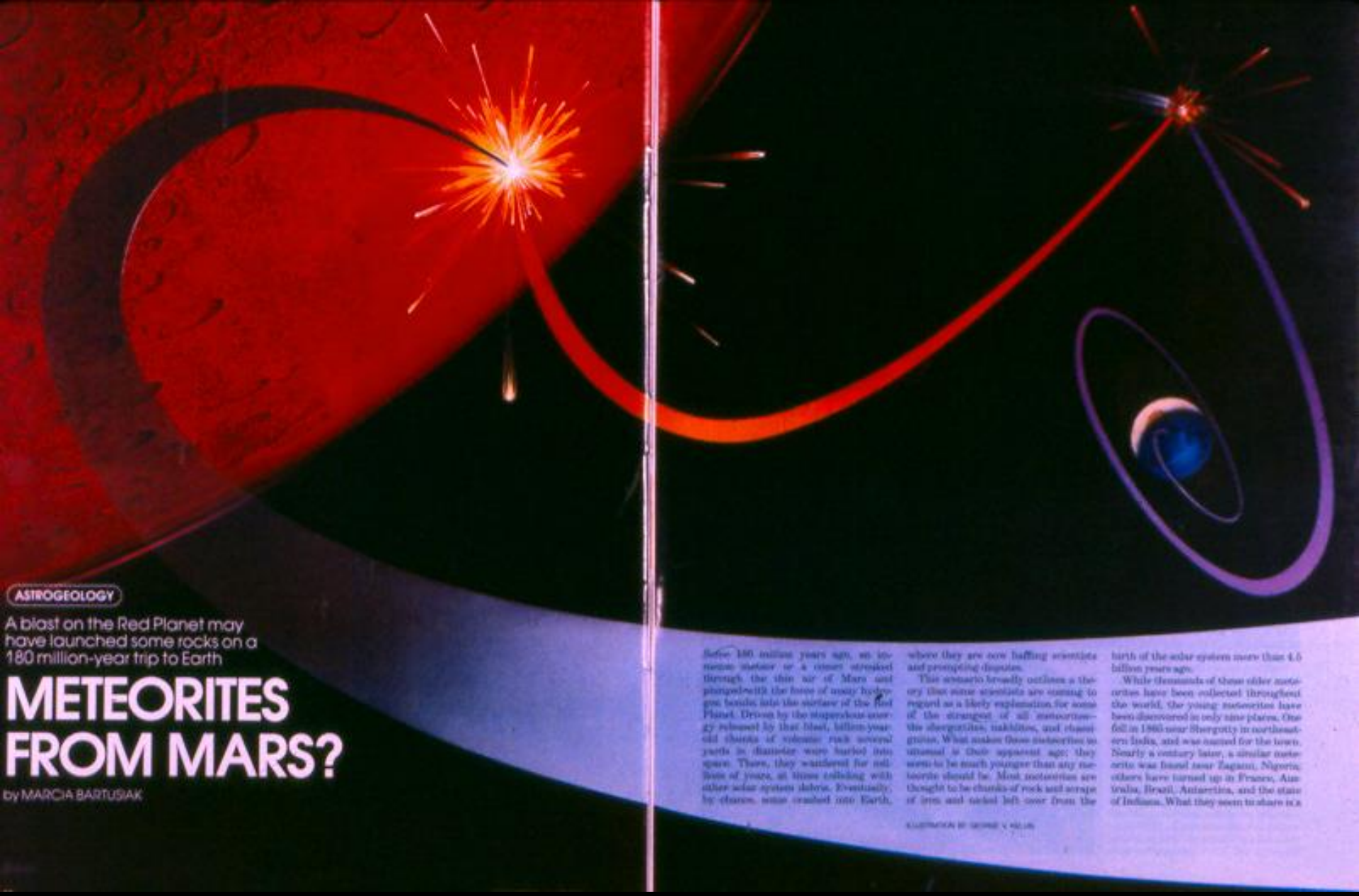


Shergottite EETA 79001


Log particles
per cm3
CO2
N2
40Ar
20Ne
36Ar
84Kr
132Xe
17
15
13
11
9
9
11
13
15
17
Mars Atmosphere
Shergottite Glass

ALHA 84001 (Antarctica)- Lunar meteorite





ASTROGEOLOGY

A blast on the Red Planet may have launched some rocks on a 180 million-year trip to Earth

METEORITES FROM MARS?

by MARCIA BARTUSIAK

Some 180 million years ago, an immense meteor or a comet streaked through the thin air of Mars and plunged with the force of many hydrogen bombs into the surface of the Red Planet. Driven by the stupendous energy released by that blast, billion-year-old chunks of volcanic rock several yards in diameter were hurled into space. There, they wandered for millions of years, at times colliding with other solar system debris. Eventually, by chance, some crashed into Earth, where they are now baffling scientists and prompting disputes.

This scenario broadly outlines a theory that some scientists are coming to regard as a likely explanation for some of the strangest of all meteorites—the shergottites, nakhlites, and chassignites. What makes these meteorites so unusual is their apparent age: they seem to be much younger than any meteorite should be. Most meteorites are thought to be chunks of rock and scraps of iron and nickel left over from the birth of the solar system more than 4.5 billion years ago.

While thousands of these older meteorites have been collected throughout the world, the young meteorites have been discovered in only nine places. One fell in 1865 near Shergotty in northeastern India, and was named for the town. Nearly a century later, a similar meteorite was found near Zagami, Nigeria; others have turned up in France, Australia, Brazil, Antarctica, and the state of Indiana. What they seem to share is a

ILLUSTRATION BY GEORGE V. KELVIN



Roger Phillips
LPI Director 1979-1982



Kevin Burke
LPI Director 1982-1988



Lunar and Planetary Institute, Houston

Workshops: Early Crustal Genesis

1981- Early Crustal Genesis: Implications from Earth (Houston)
1985- The Earth as a Planet (Houston)
1985- Early Earth: Accretion to Older Archean (Houston)
1986- Tectonic Evolution of Greenstone Belts (Houston)
1988- Growth of Continental Crust (Oxford University)
1989- Archean Mantle (Houston)

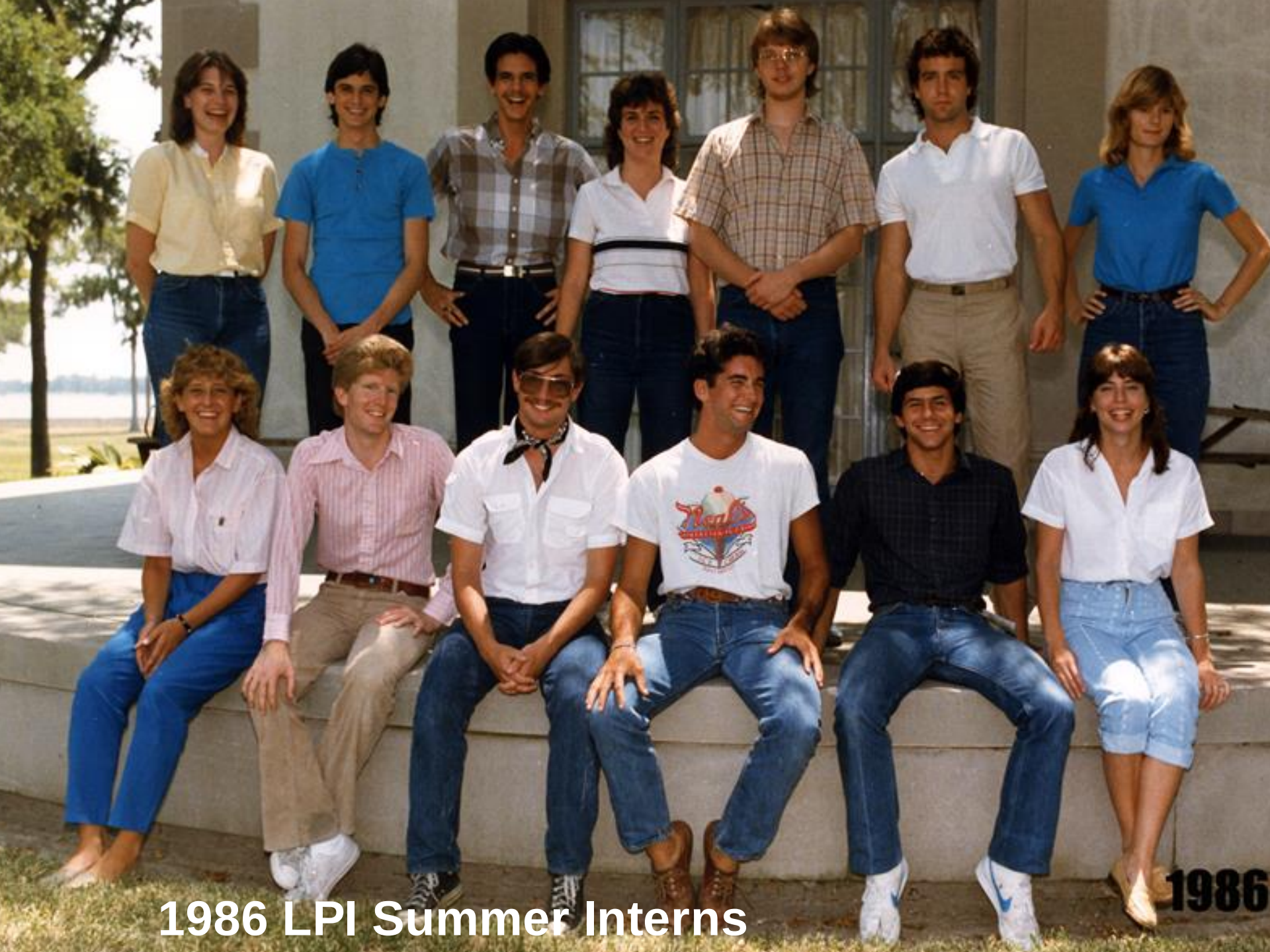
Field Workshops

1982- Magmatic Processes of Early Planetary Crusts
(Beartooth Mountains, Montana)

1983- A Cross Section of Archean Crust
(Kapuskasing, Ontario)

1986- World's Oldest Rocks
(West Greenland)

1988- Deep Continental Crust of South India
(Hyderabad & Southern India)

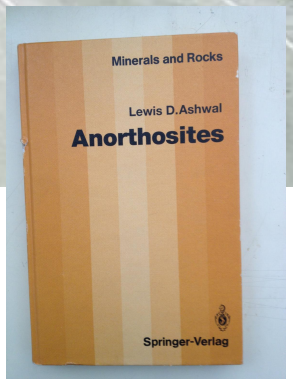


1986 LPI Summer Interns

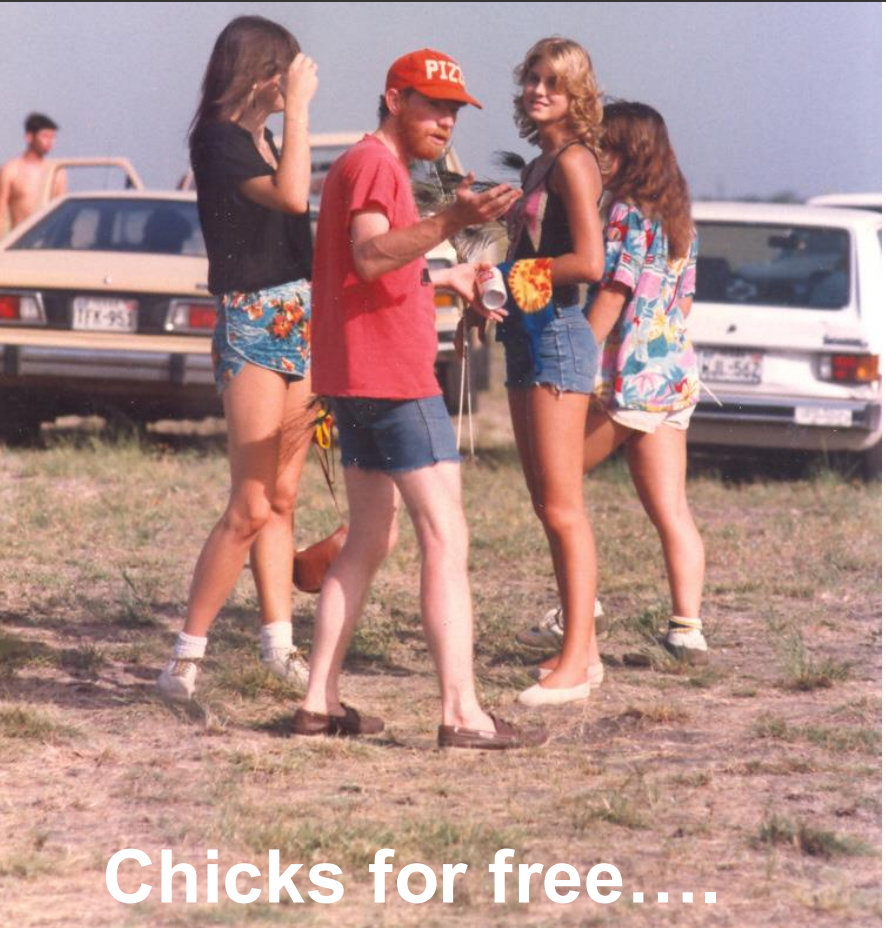

Mike Colucci



I-45 Dallas → Houston







Grateful Dead, Manor Downs, Texas, 1982





The Bags, 1988

Earth and Planetary Science Letters, 96 (1989) 8–14
Elsevier Science Publishers B.V., Amsterdam – Printed in The Netherlands

[6]

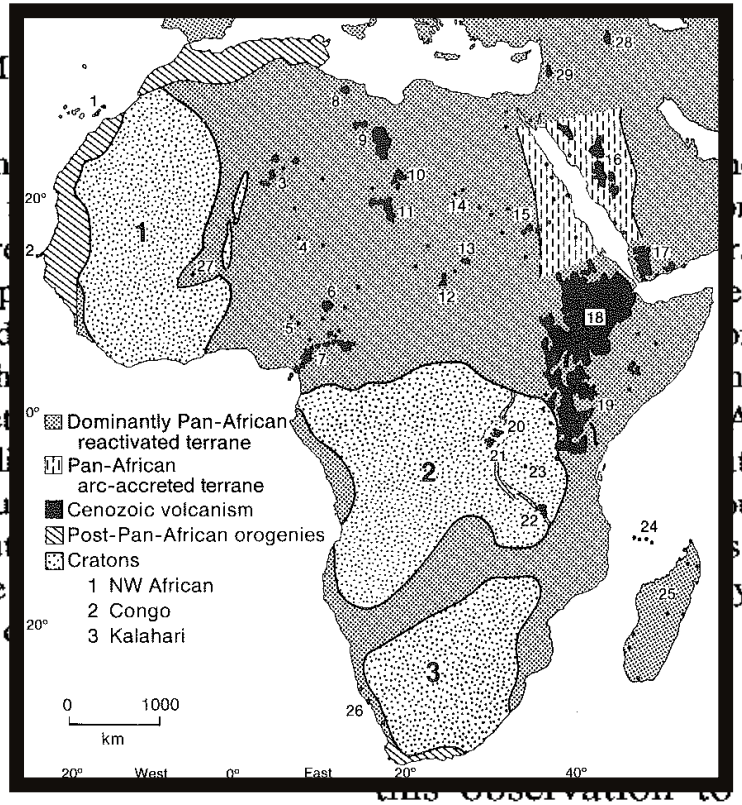
African lithospheric structure, volcanism, and topography

Lewis D. Ashwal and Kevin Burke

Lunar and Planetary Institute, 3303 NASA Road One, Houston, TX 77058 (U.S.A.)

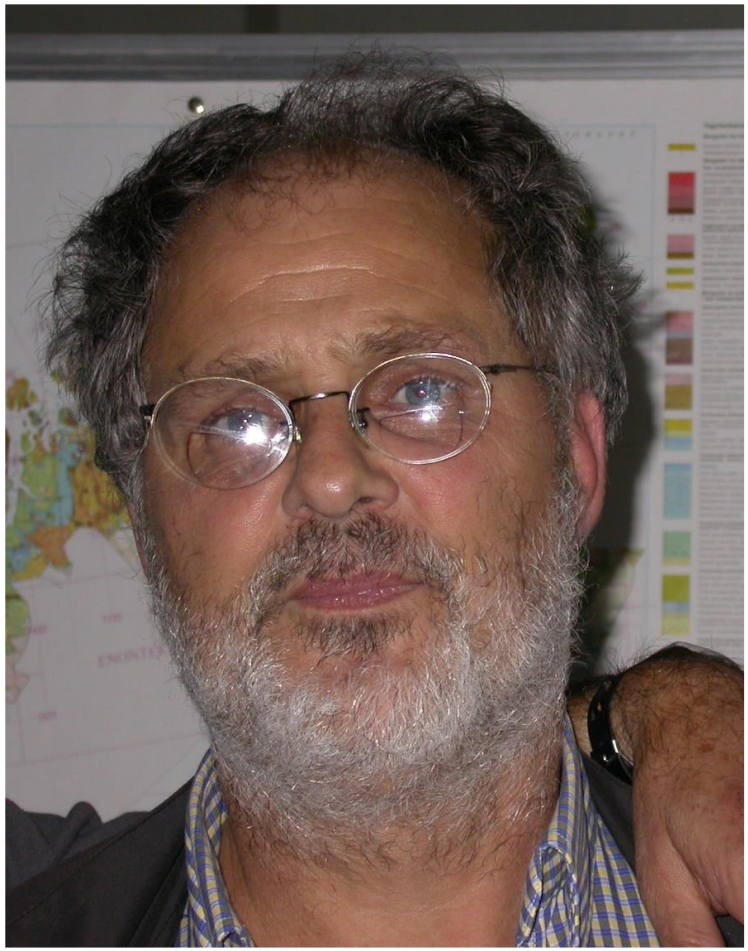
Received M 1989

In Africa volumetrically minor, m ncentrated in areas affected by Pan-African (500 ± 150 Ma) crustal nic areas. We interpret this as indicating that Pan-African areas ar ratons by depleted lithospheric mantle, and propose a model to exp e two kinds of African mantle lithosphere: (1) Cratons were formed r this reason are underlain by depleted, sub-oceanic-type mantle lith here has been delaminated from beneath areas thickened during Tibet African times) and replaced by fertile material which now forms the l ted crust. (3) When the African plate came to rest with respect to su ut 30 Ma, heating from below extracted magmas from the fertile but s a result of interaction with an underlying convective pattern for the y both Neogene elevations and volcanism but cratonic areas display



Introduction

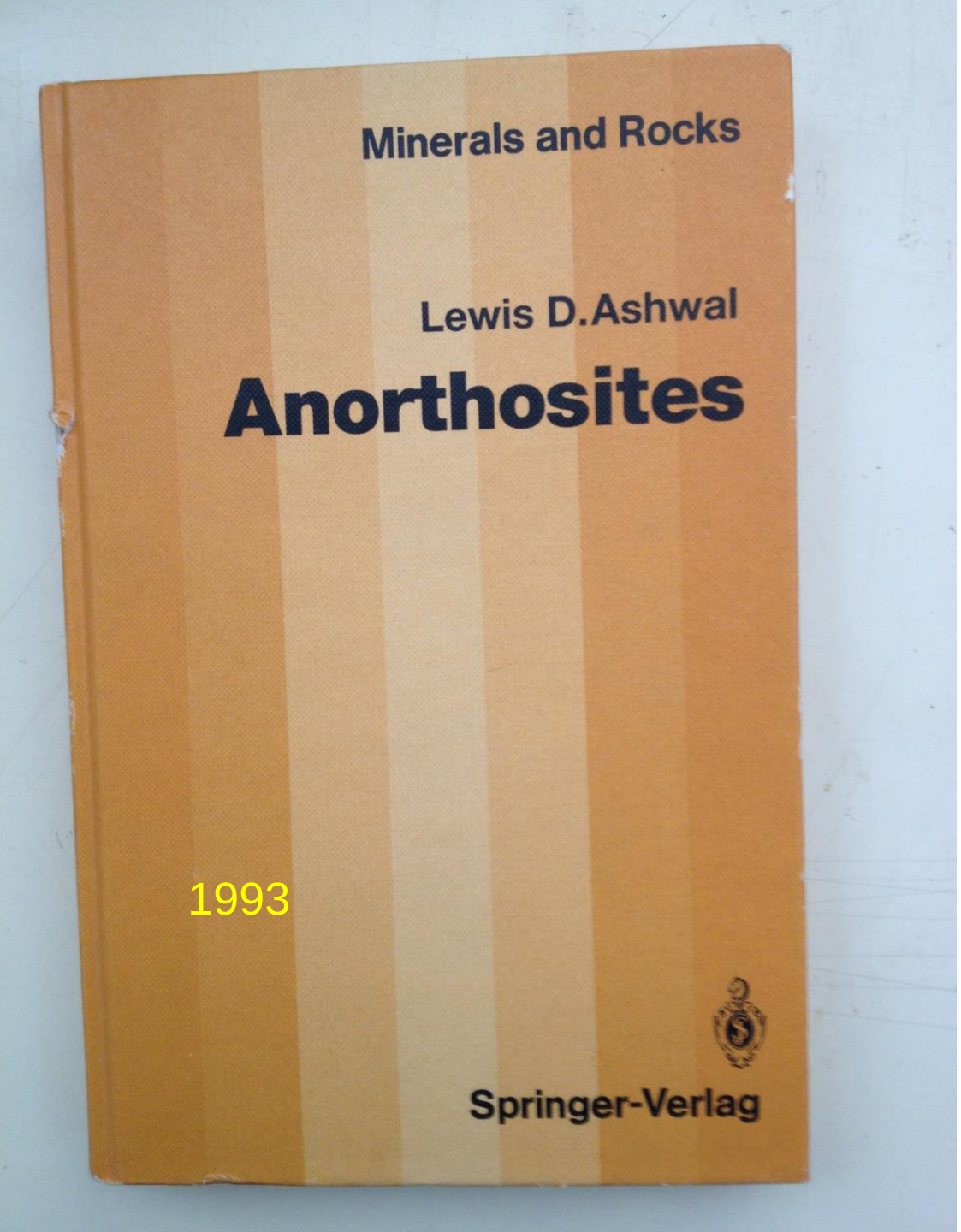
the whole continent showing



Maarten de Wit (2003)



Chris Roering (1995)



6 Types of Anorthosite

1. Archean megacrystic

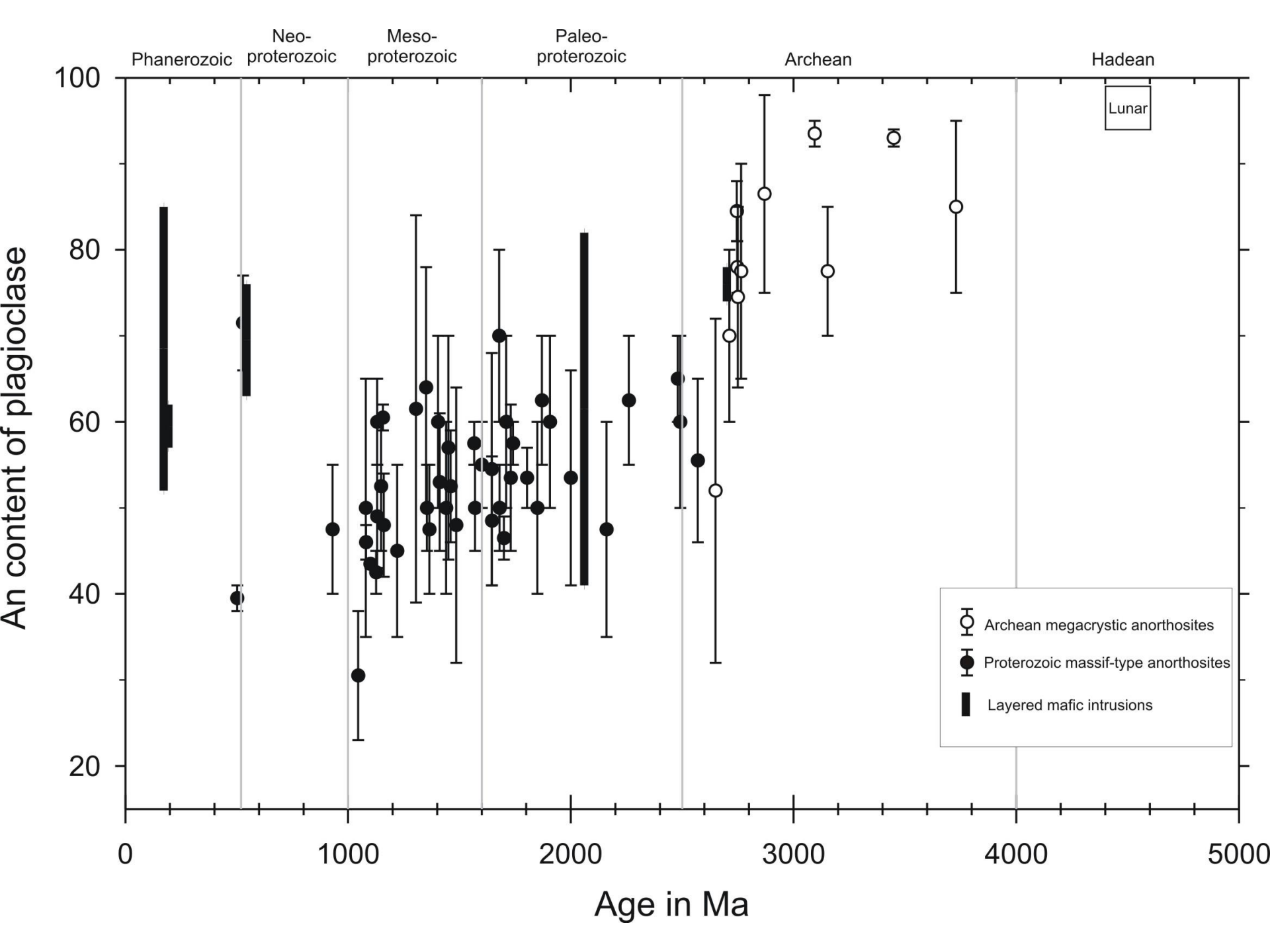
2. Proterozoic massif

3. Stratiform (layered intrusion)

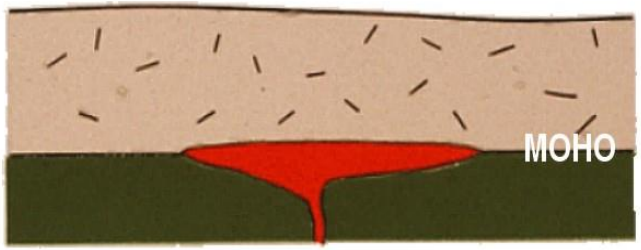
4. Oceanic
   - mid-ocean ridge
   - ophiolite

5. Inclusions
   - cognate
   - xenolithic

6. Extraterrestrial


Phanerozoic
Neo-
proterozoic
Meso-
proterozoic
Paleo-
proterozoic
Archean
Hadean
Lunar
An content of plagioclase
100
80
60
40
20
0
1000
2000
3000
4000
5000
Age in Ma
Archean megacrystic anorthosites
Proterozoic massif-type anorthosites
Layered mafic intrusions

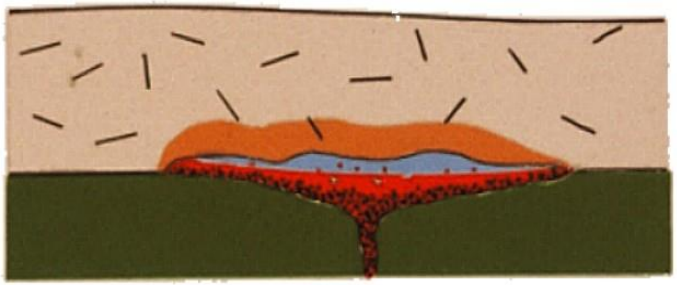
1. Basaltic or picritic underplating



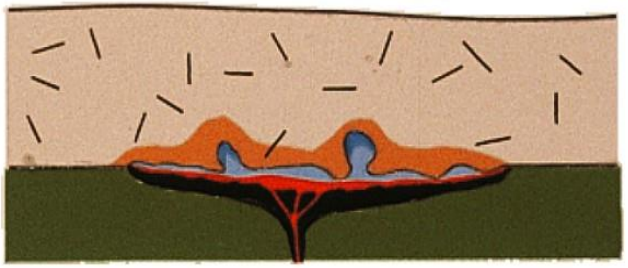
2. Mafics crystallize and sink; crustal anatexis



3. Plagioclase floats; instabilities develop

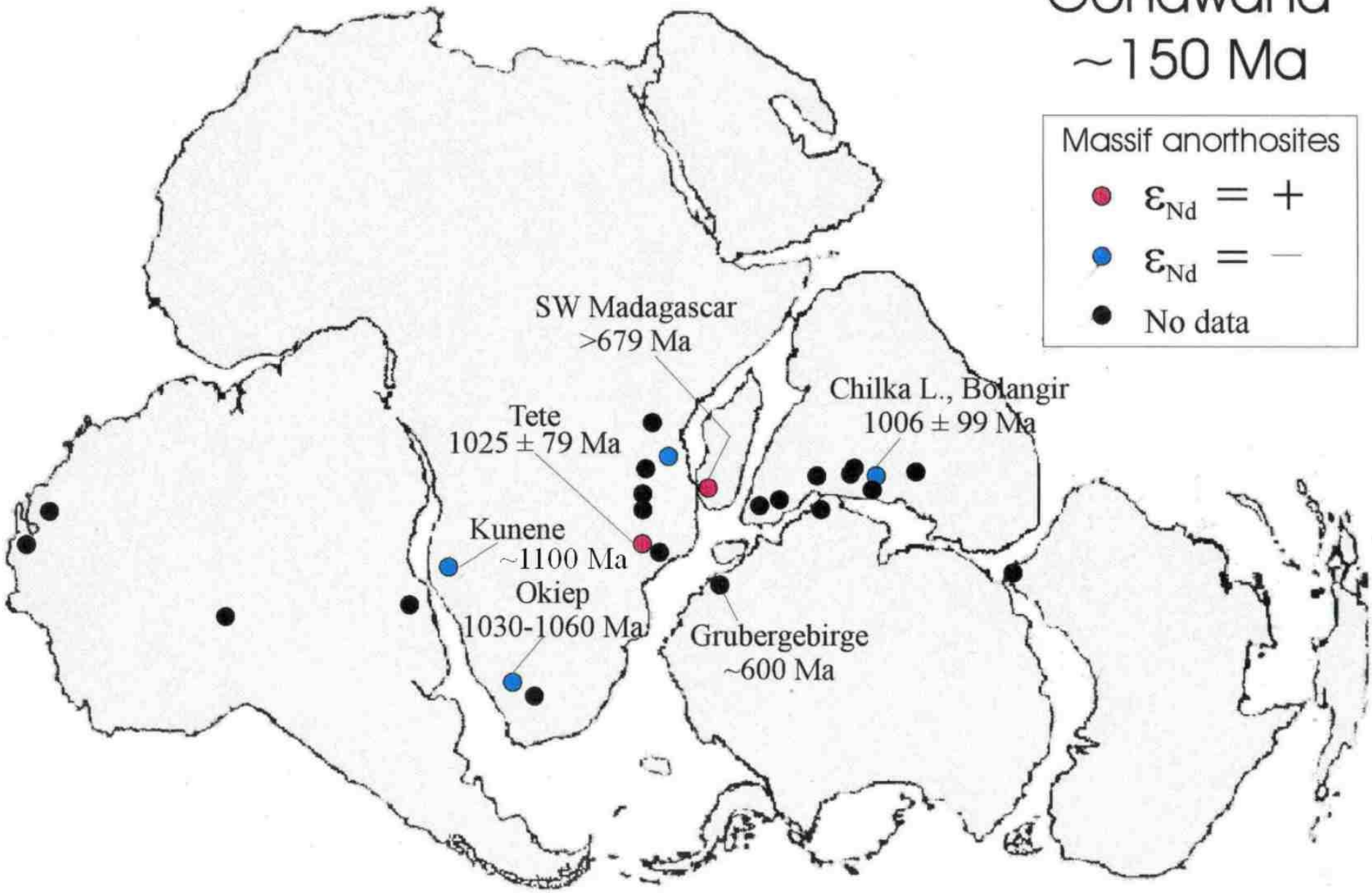


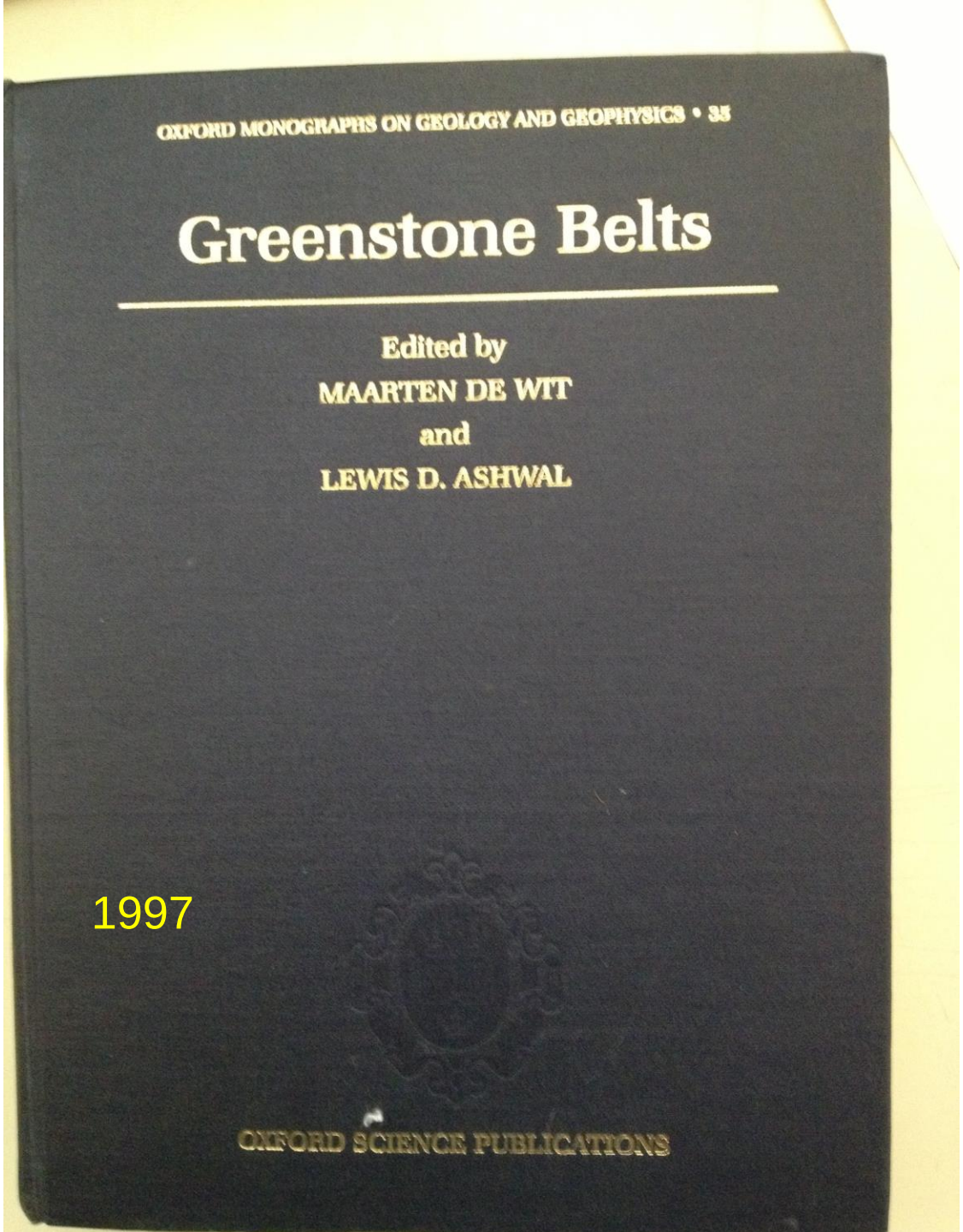
4. Anorthosite mushes ascend as plutons

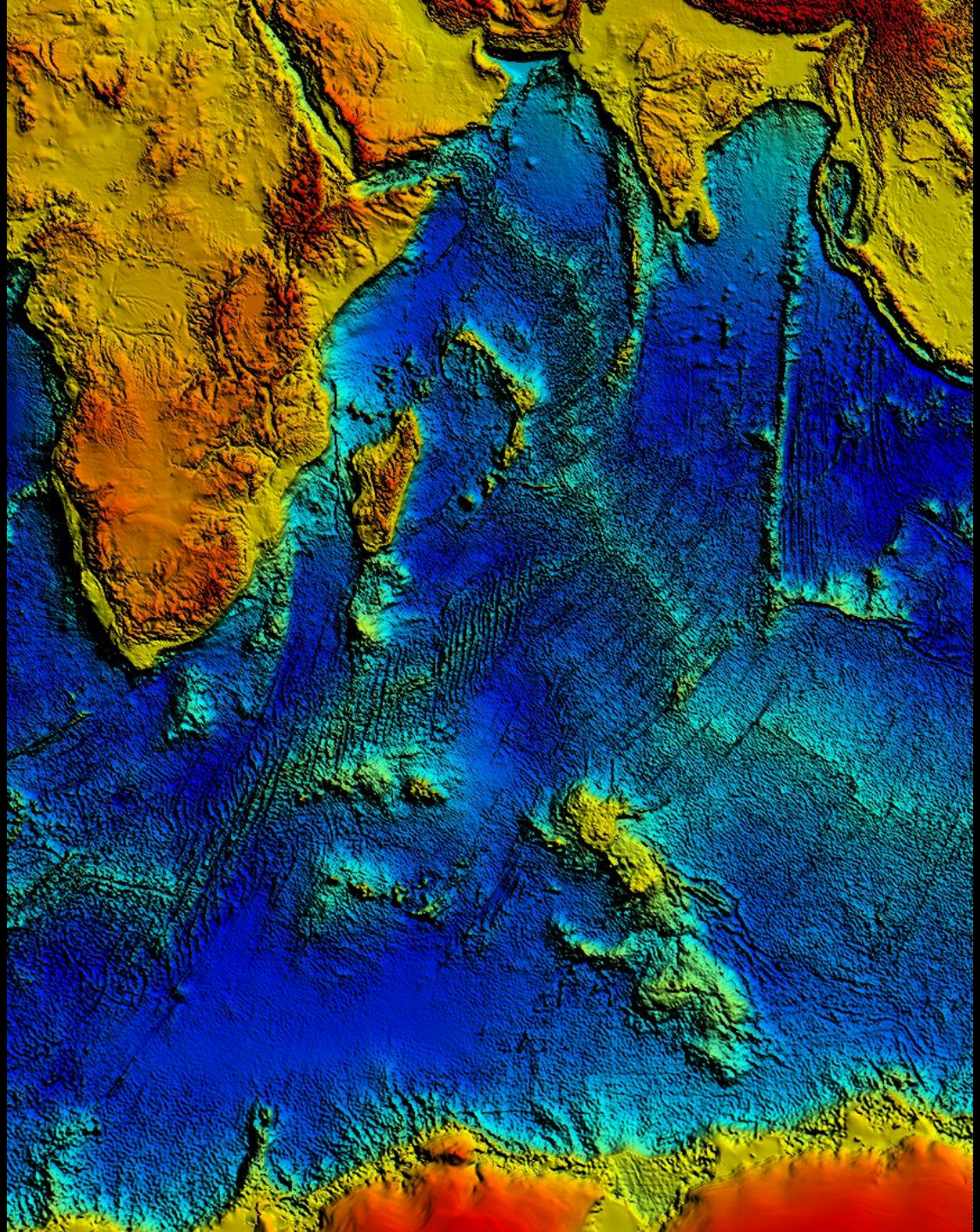


5. Plutons coalesce in upper crust to form massifs; ultramafics sink




Gondwana
~150 Ma
Massif anorthosites
εNd = +
εNd = −
No data
SW Madagascar
>679 Ma
Chilka L., Bolangir
1006 ± 99 Ma
Tete
1025 ± 79 Ma
Kunene
~1100 Ma
Okiep
1030-1060 Ma
Grubergebirge
~600 Ma


OXFORD MONOGRAPHS ON GEOLOGY AND GEOPHYSICS • 35
Greenstone Belts
Edited by
MAARTEN DE WIT
and
LEWIS D. ASHWAL
1997
OXFORD SCIENCE PUBLICATIONS





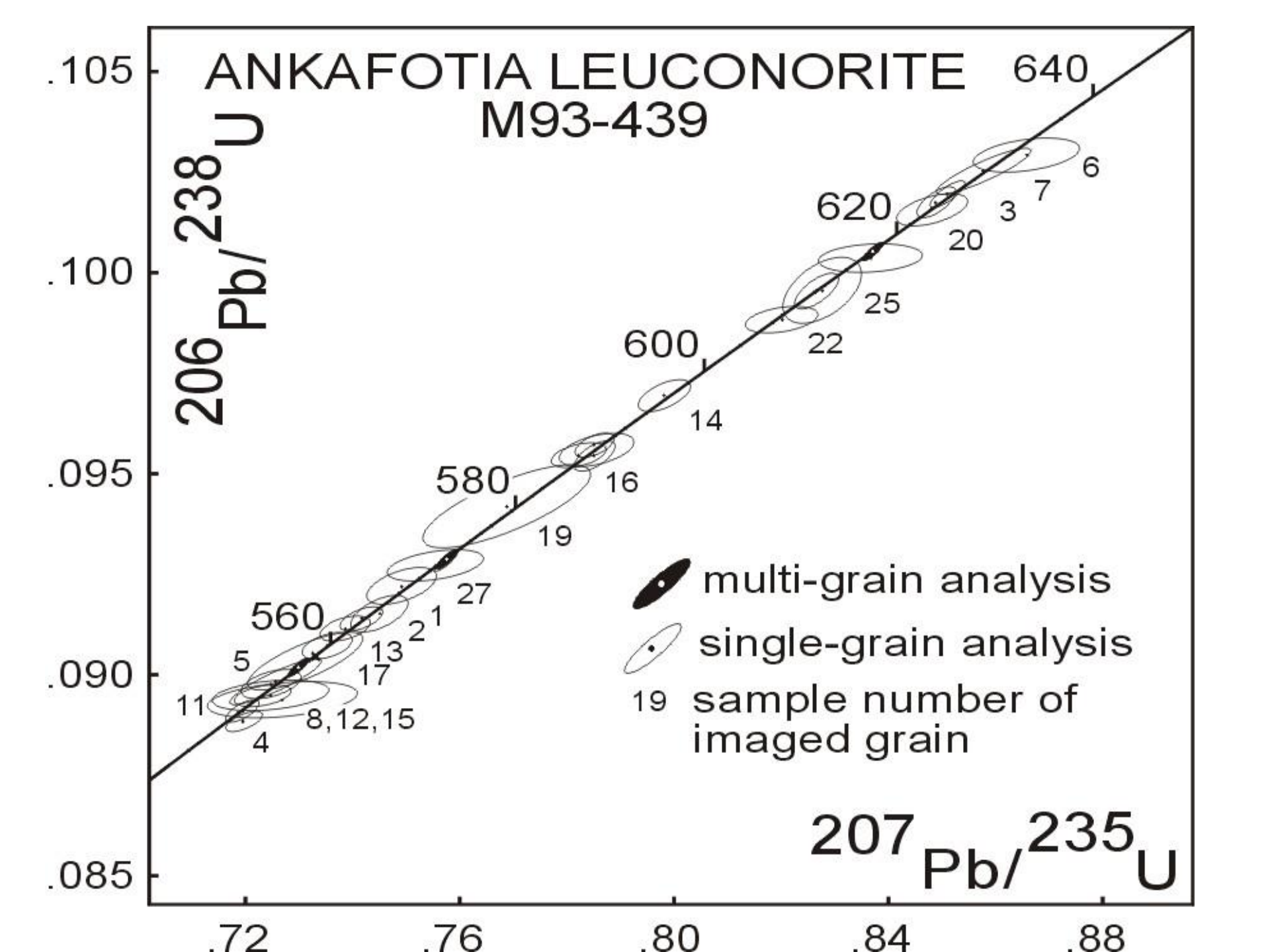
Ampanihy Shear Zone,
SW Madagascar


TAMATAVE
ILE SAINTE MARIE
ANTARA
BONGOLAVA
BEMARAHA
MAHAFALY
ANDRIAMENA
ANKARANA
IKAMAVO
KELIFELY
TSIRIBIHINA
MANDRAREZINA
MANDRALAVA
ANDRAMENA
ANONY
ANJOLY
MANAMBOLO
MANGORO
MANAMBAO
MANAMBOLOMADIRO
MANAMBOLOMAHAVAVY
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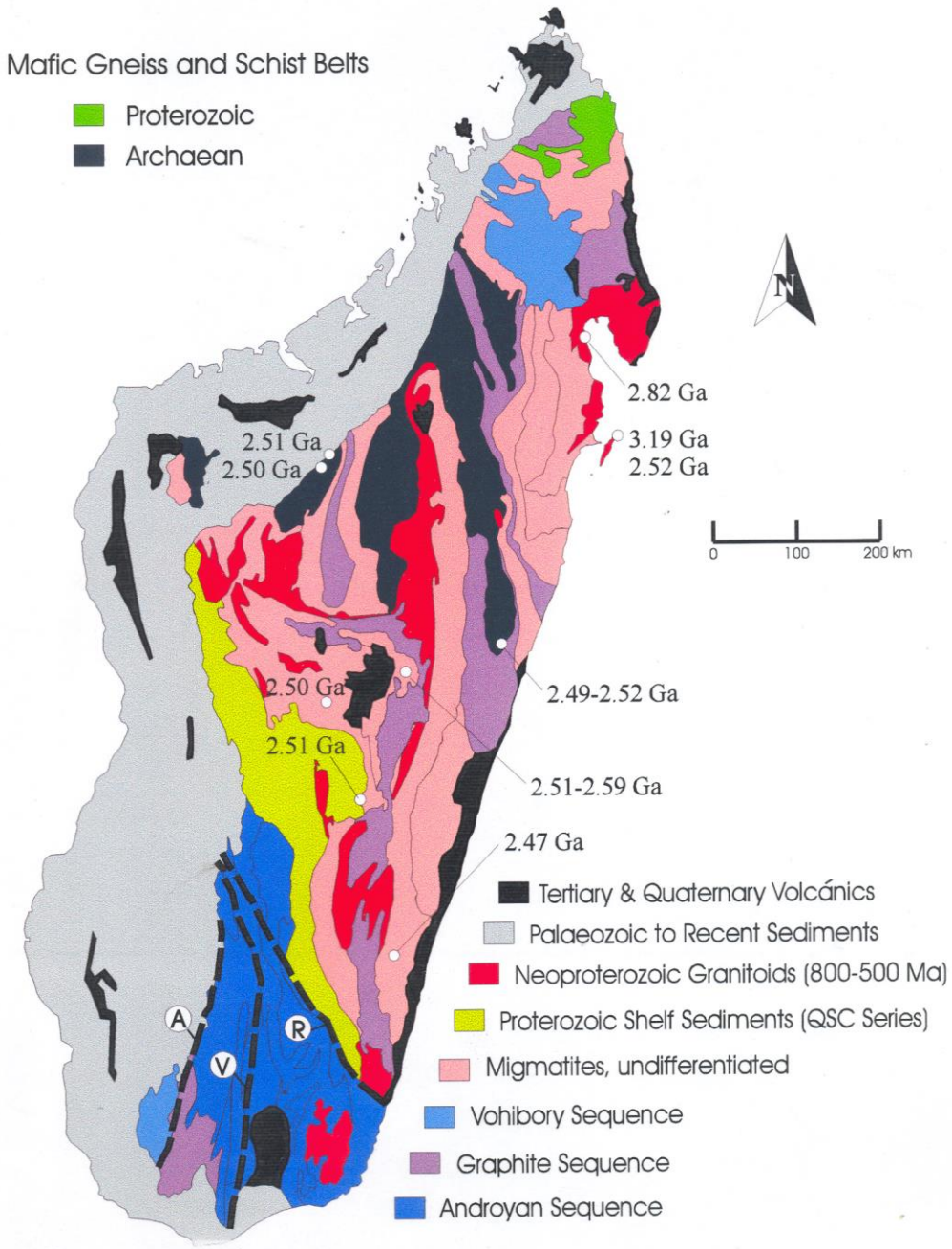


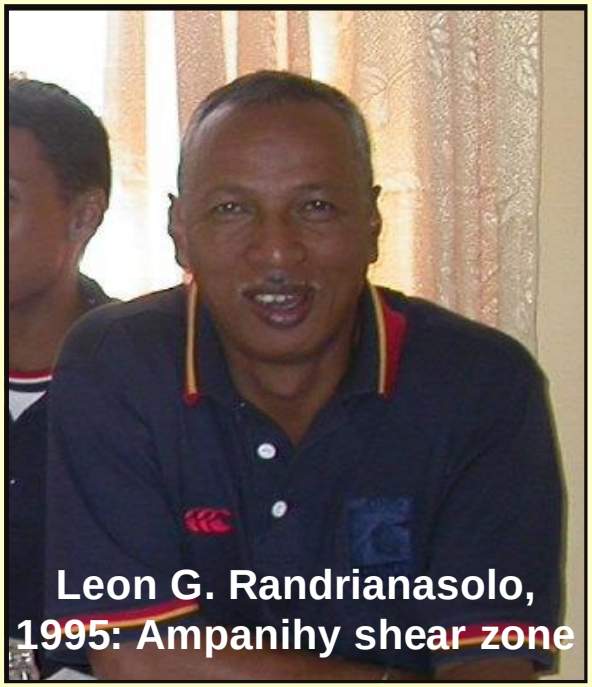
Richard Viljoen

Ankafotia anorthosite, SW Madagascar, 1992

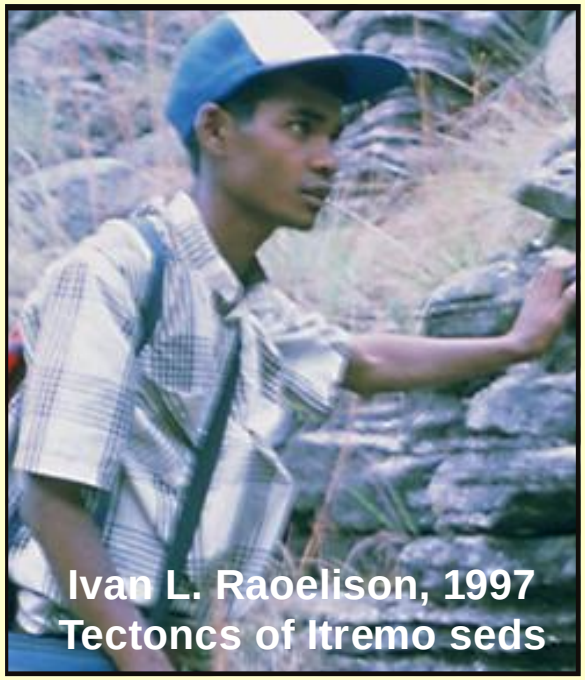

ANKAFOTIA LEUCONORITE
M93-439
$^{206}Pb/^{238}U$
$^{207}Pb/^{235}U$
.105
.100
.095
.090
.085
.72
.76
.80
.84
.88
640
620
600
580
560
multi-grain analysis
single-grain analysis
19 sample number of imaged grain

Madagascar, Generalized Geology

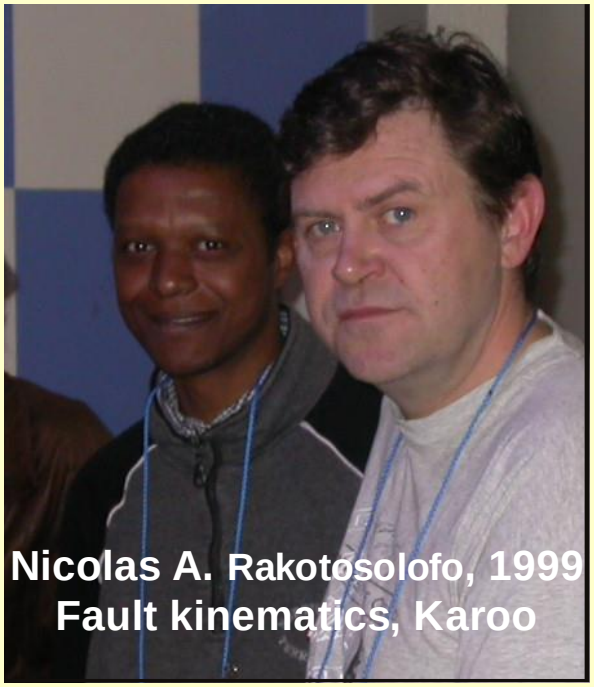




Leon G. Randrianasolo,
1995: Ampanihy shear zone



Ivan L. Raoelison, 1997
Tectoncs of Itremo seds

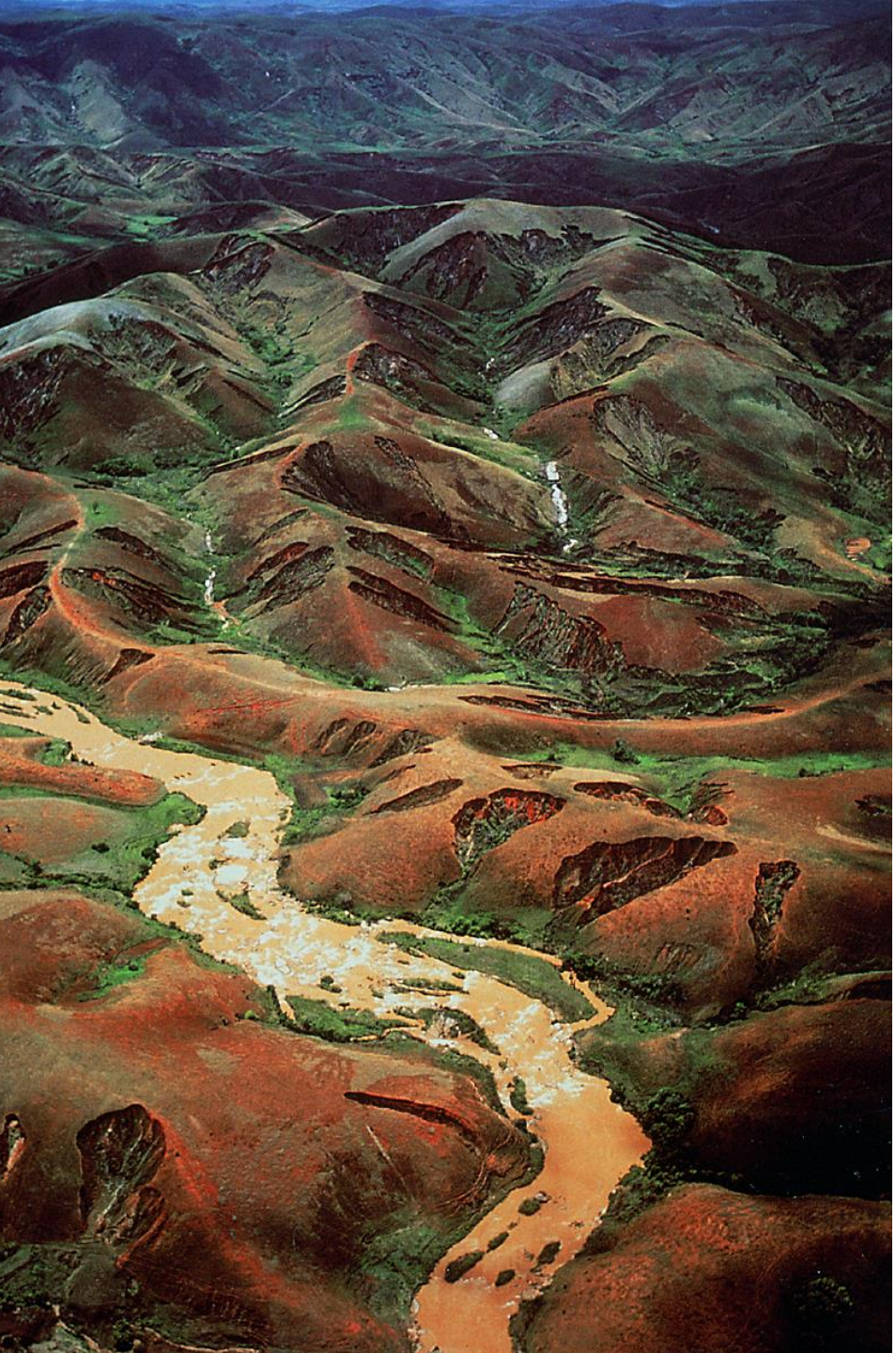


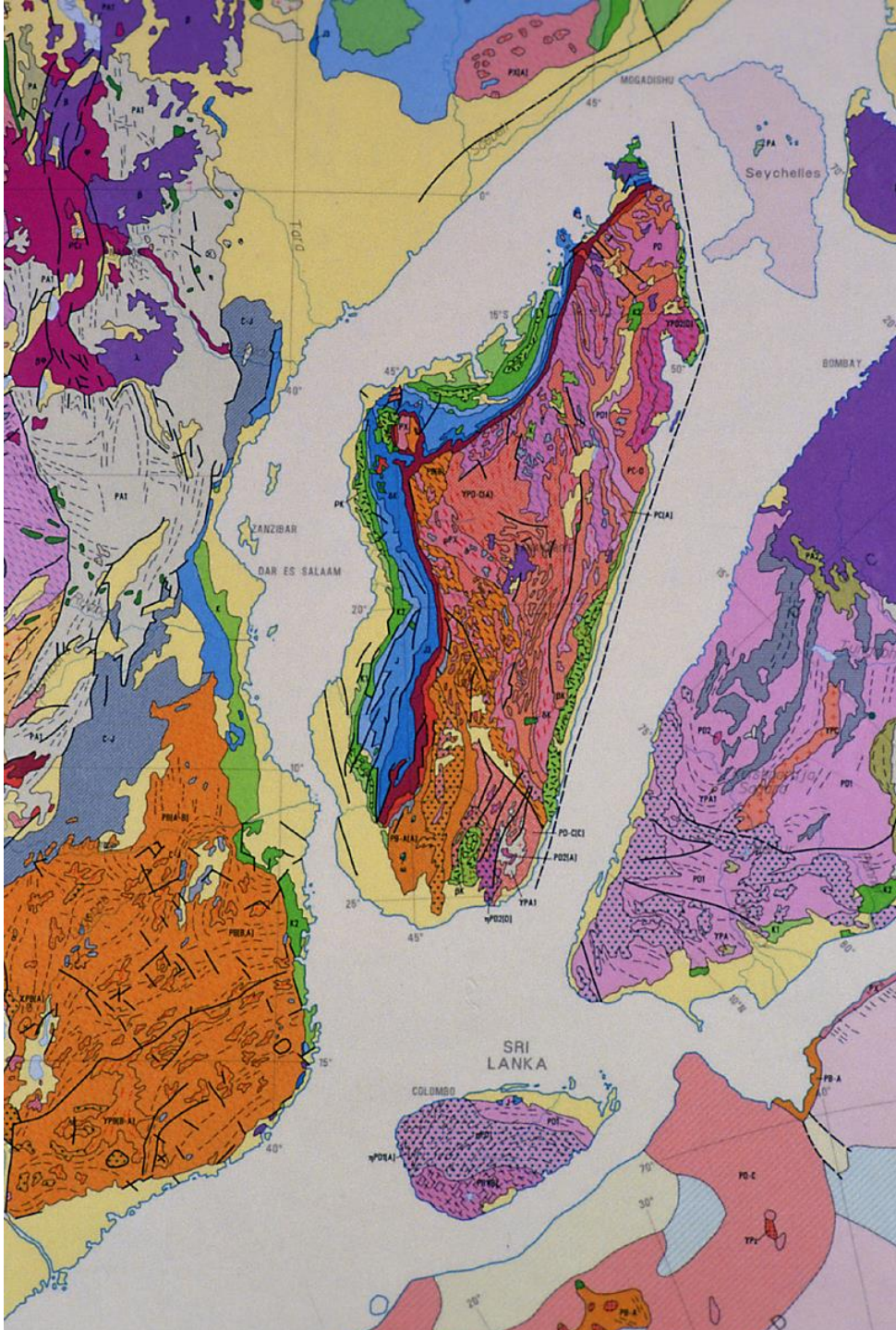
Nicolas A. Rakotosolofo, 1999
Fault kinematics, Karoo

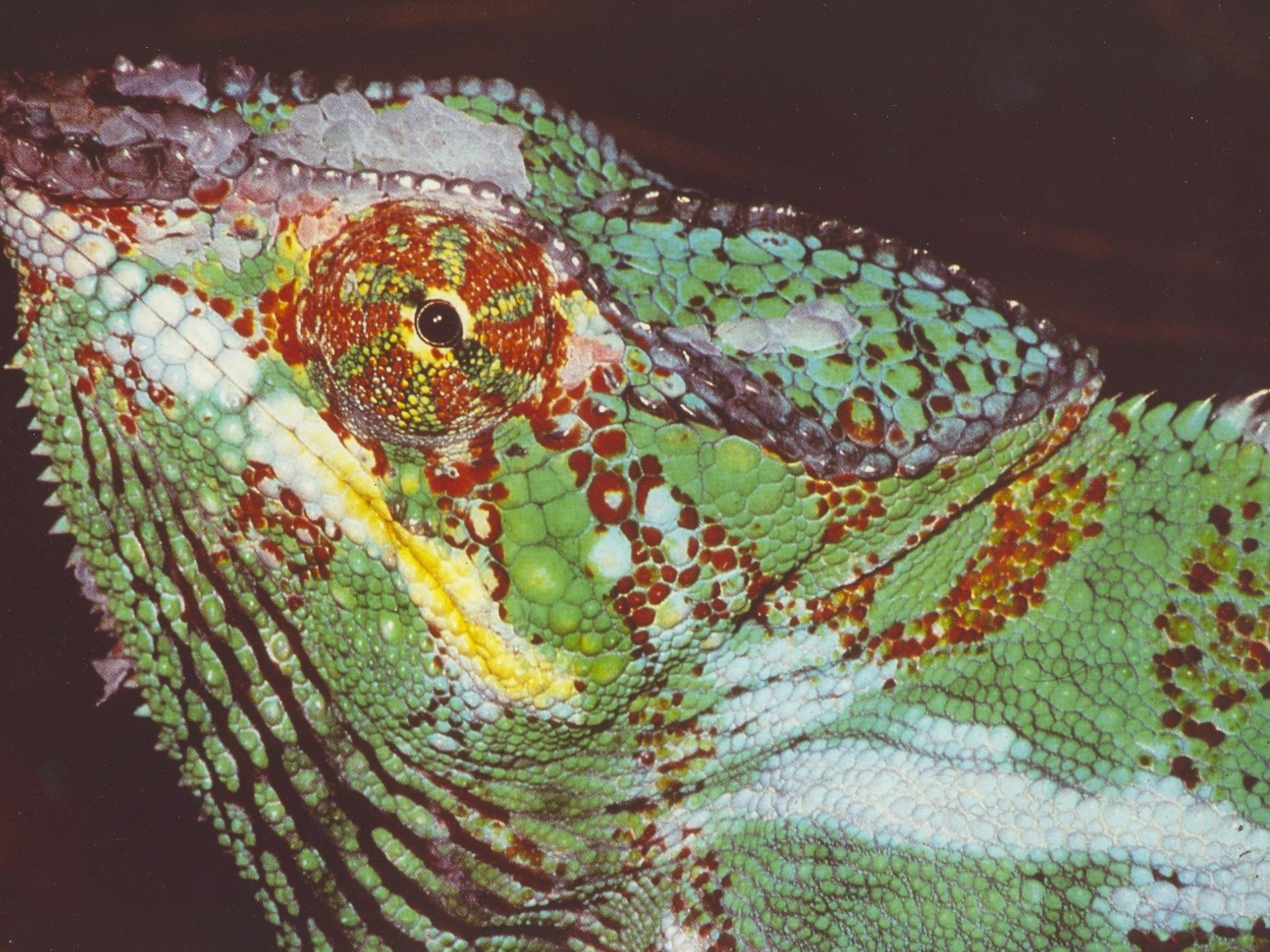


Rindrahasy H. Rakotoarimanana
2001: Granite-hosted Gold






MOGADISHU
Seychelles
BOMBAY
ZANZIBAR
DAR ES SALAAM
SRI
LANKA
COLOMBO









Mike Knoper

The Bushveld Complex
(see enlarged, below)

Republic of South Africa

Northern Limb

WATERBERG

TWEESPALK

WAR SPRINGS

Eastern Limb

WBJV - PTM/PLG
Feasibility Study Complete

Anglo Platinum
Amandelbult
Northam JV

Anglo Platinum
Union

Barrick Gold Corp.
Sedibelo

Royal Bafokeng/
Anglo Styldrift Development

BRPM Mine

Platmin
Pilanesberg

Impala
Platinum

Impala
(Afplats)

Eastern Platinum
Crocodile

PTM/PLG-SABLE
JOINT VENTURE

Pretoria

Xstrata
Eland-NKWE

Anglo
Platinum
Pandora

Lonmin

Anglo
Platinum
Rustenberg

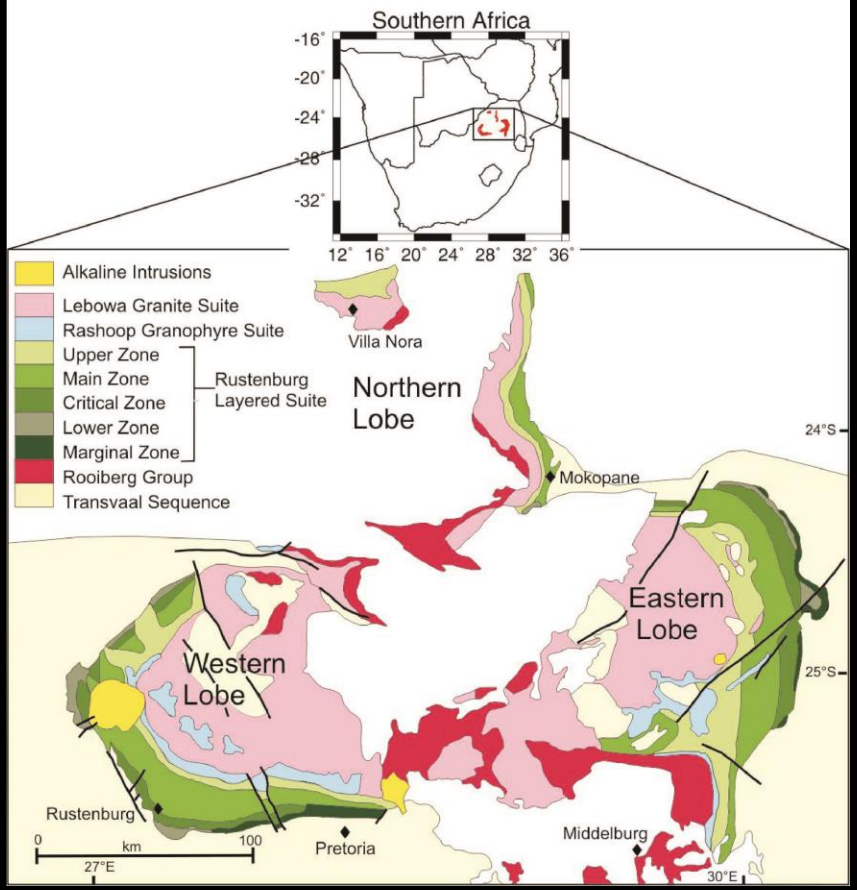
Johannesburg

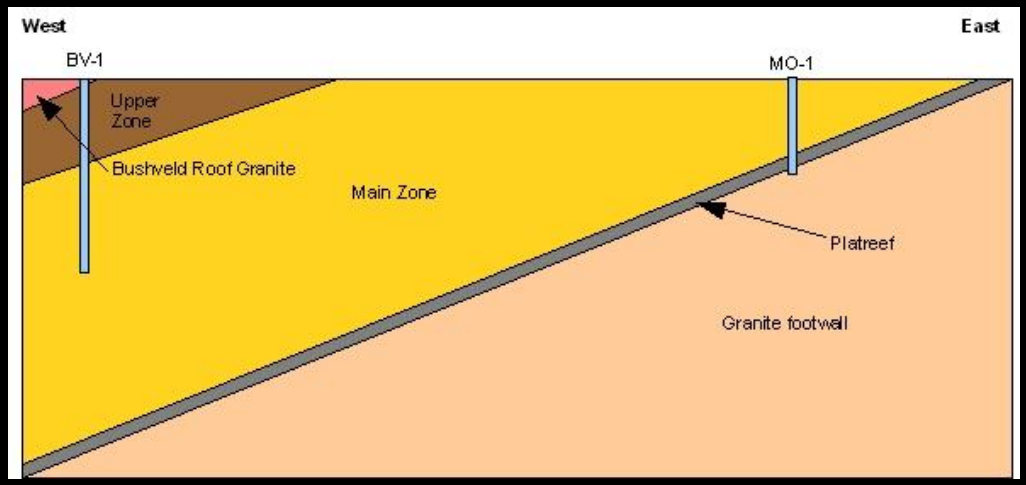
Western Limb

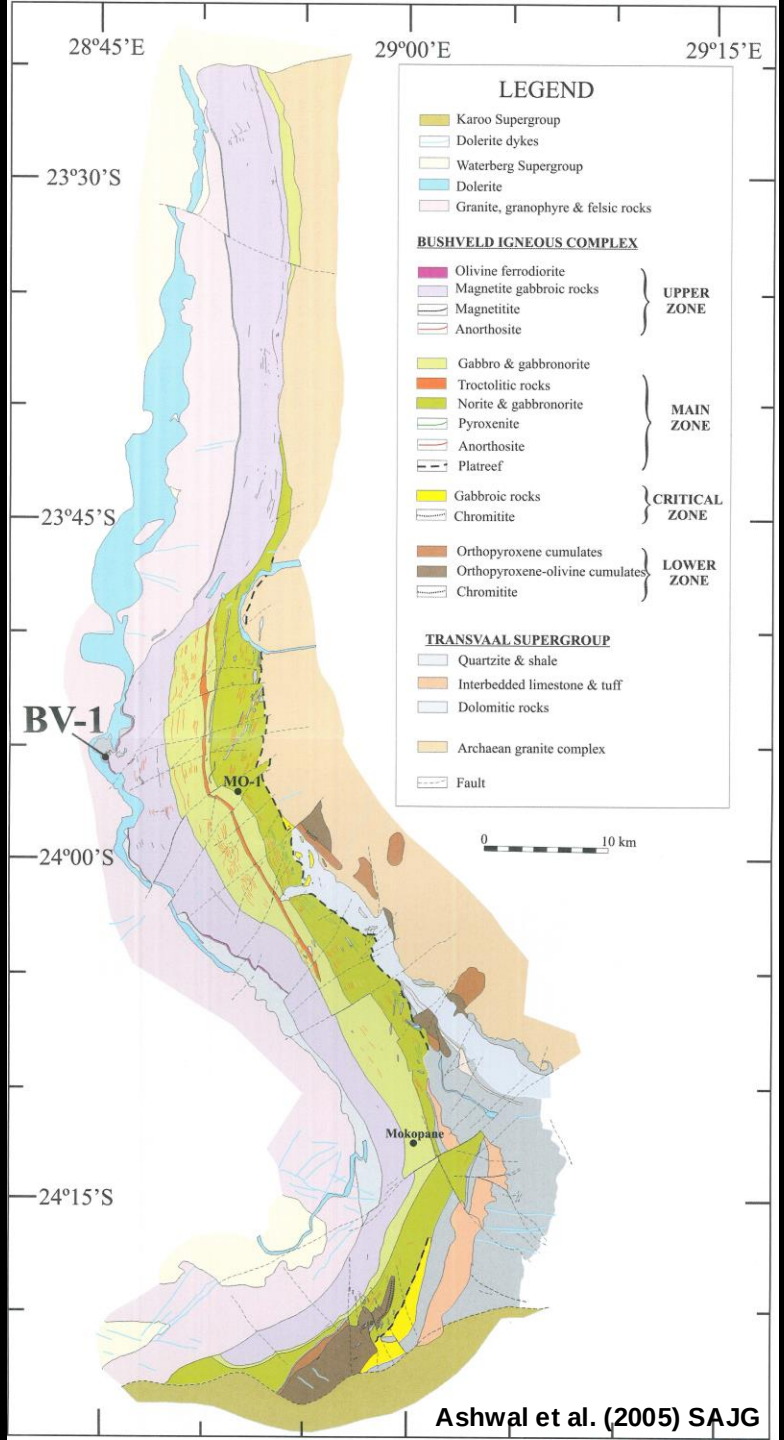
Mine Shafts
Mined Out Areas
Merensky Reef
UG2 Reef

PLATINUM GROUP METALS

PLG:NYSE AMEX







Ashwal et al. (2005) SAJG







681 samples

Magnetic susceptibility: **n = 109,506**

Density: **n = 2,409**

Microprobe:

plag:	5,748
opx:	4,469
cpx:	4,585
oliv:	949
biot:	854
amph:	524
mag:	1,166
ilm:	278
TOTAL:	**18,573**





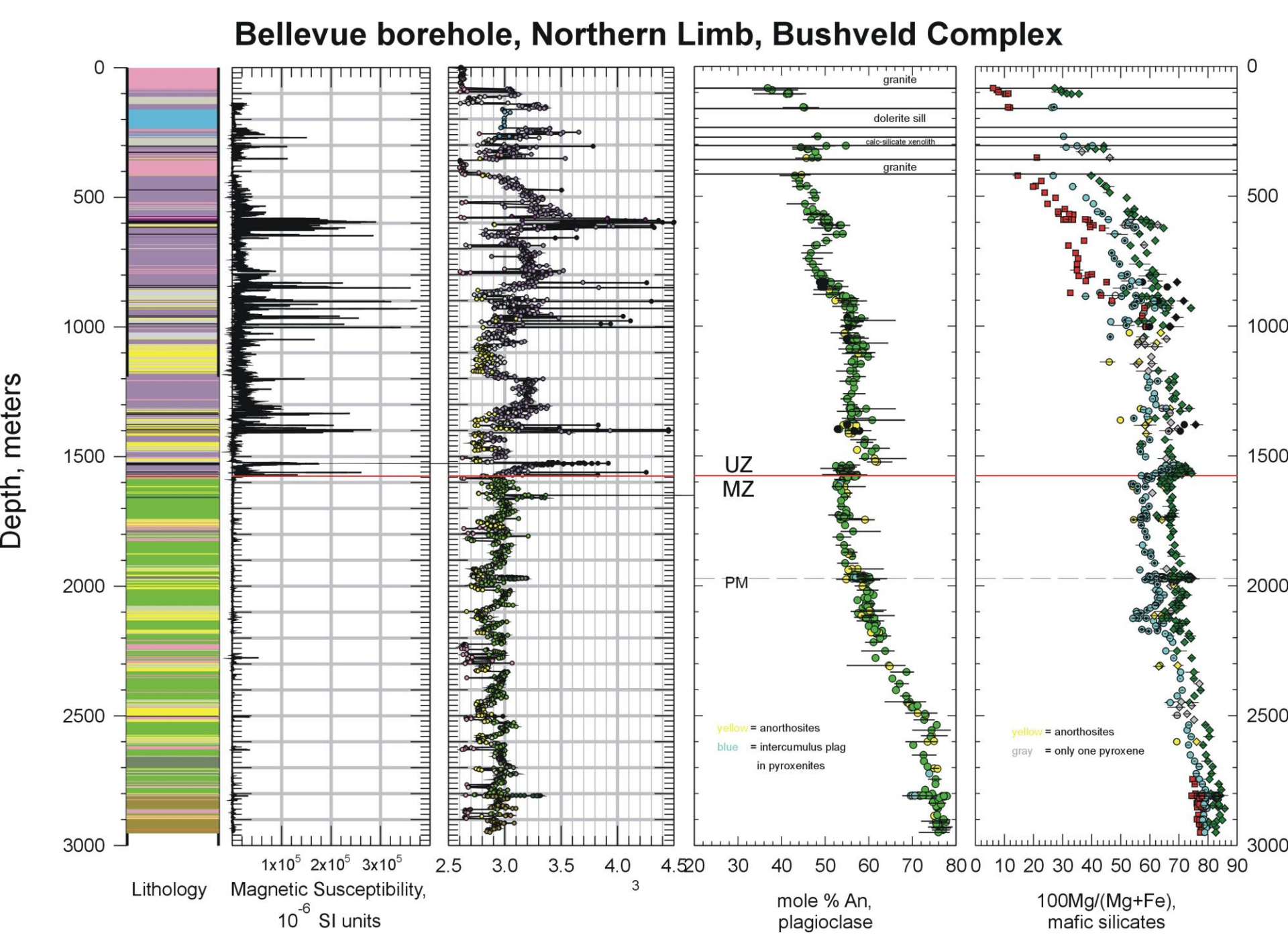
Sampling intervals

Mag: **1-2 cm**

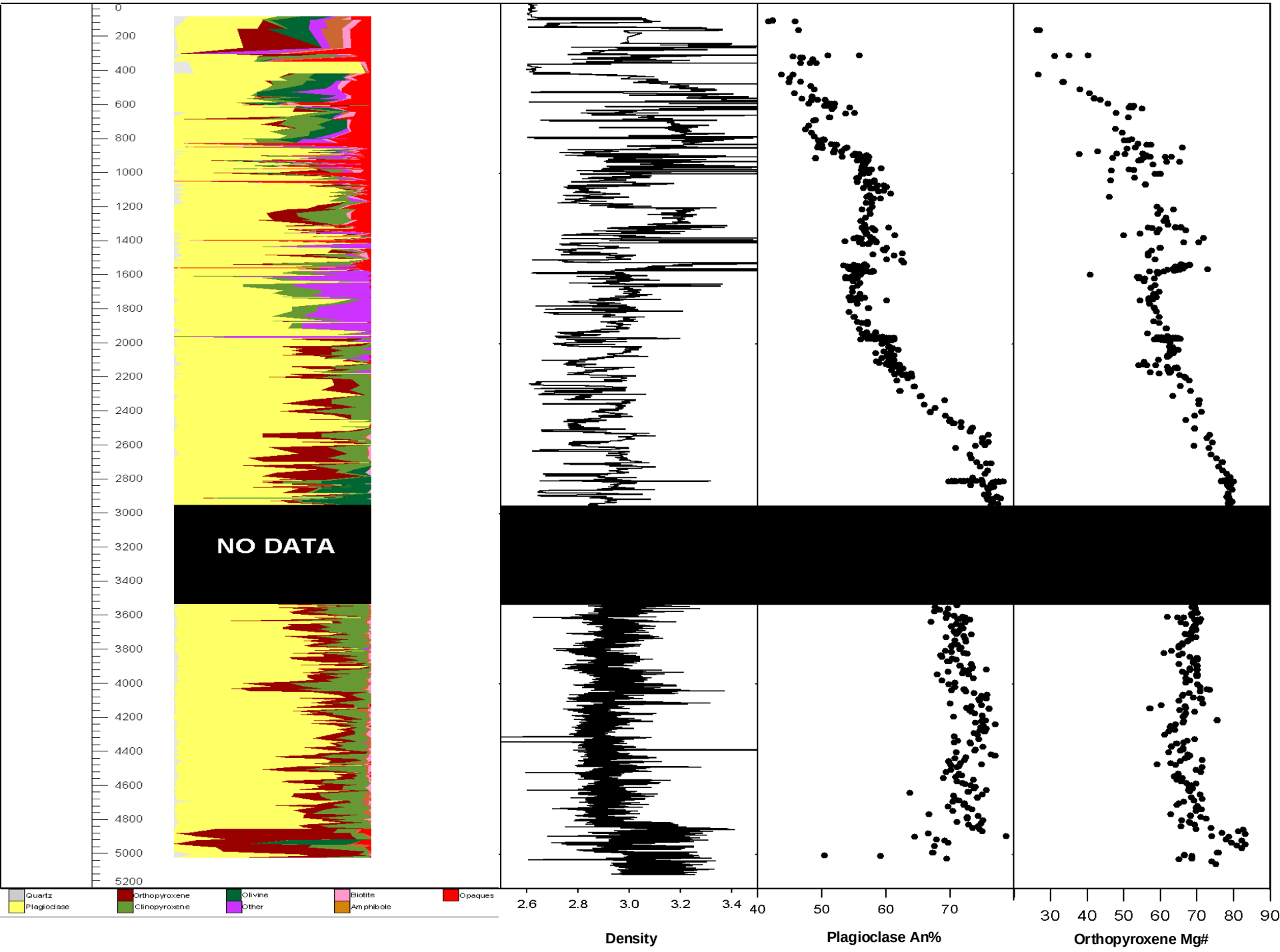
Density: **~1.5 - 2 m**

Rock & min chem: **~6 - 7 m**

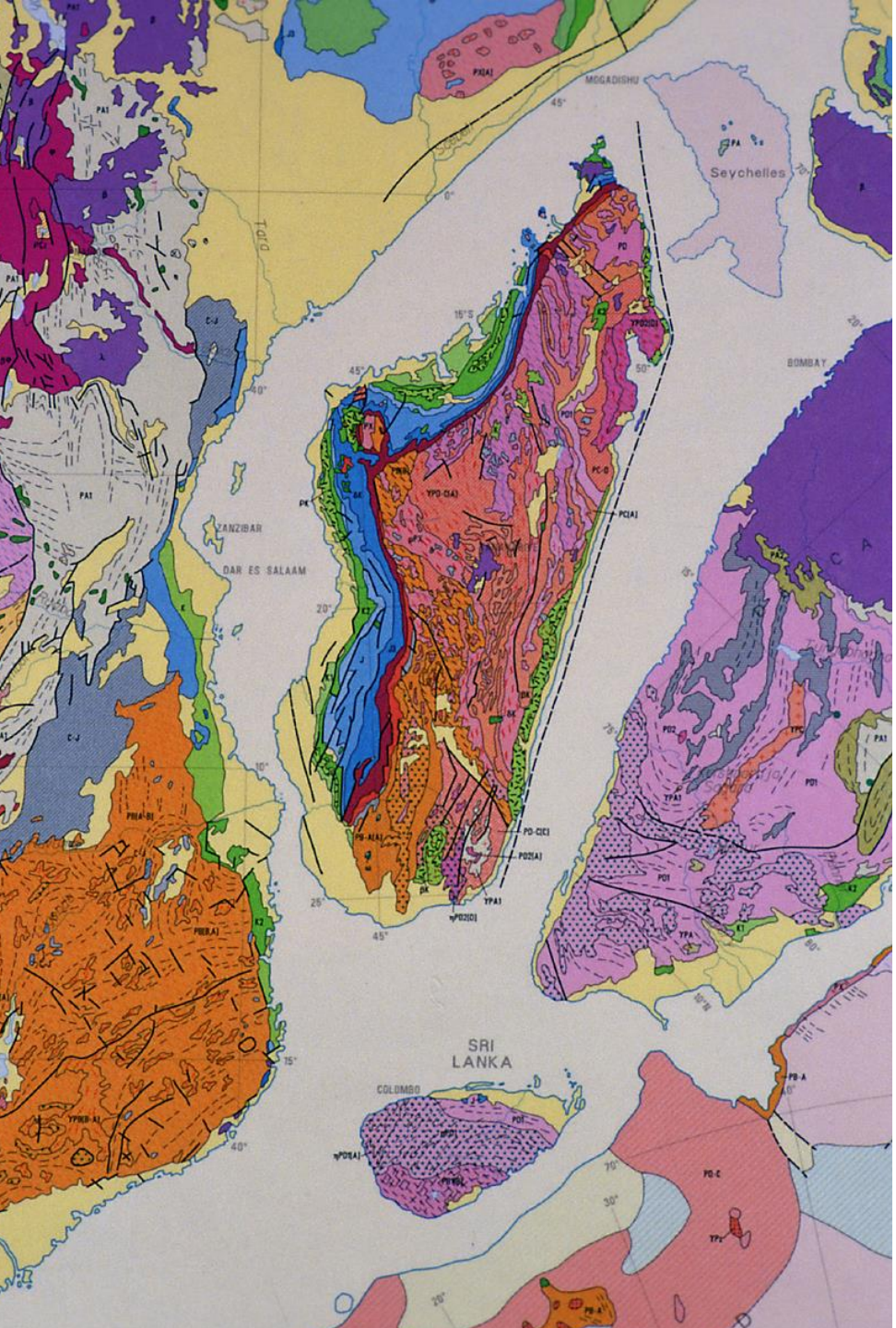
Near-continuous dataset for entire Bushveld stratigraphy, Northern Lobe



Ashwal et al. (2005) SAJG


0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200
NO DATA
Quartz
Plagioclase
Orthopyroxene
Clinopyroxene
Olivine
Other
Biotite
Amphibole
Opaques
2.6
2.8
3.0
3.2
3.4
Density
40
50
60
70
Plagioclase An%
30
40
50
60
70
80
90
Orthopyroxene Mg#


Trond H. Torsvik
~1995


MOGADISHU
Seychelles
BOMBAY
ZANZIBAR
DAR ES SALAAM
SRI
LANKA
COLOMBO

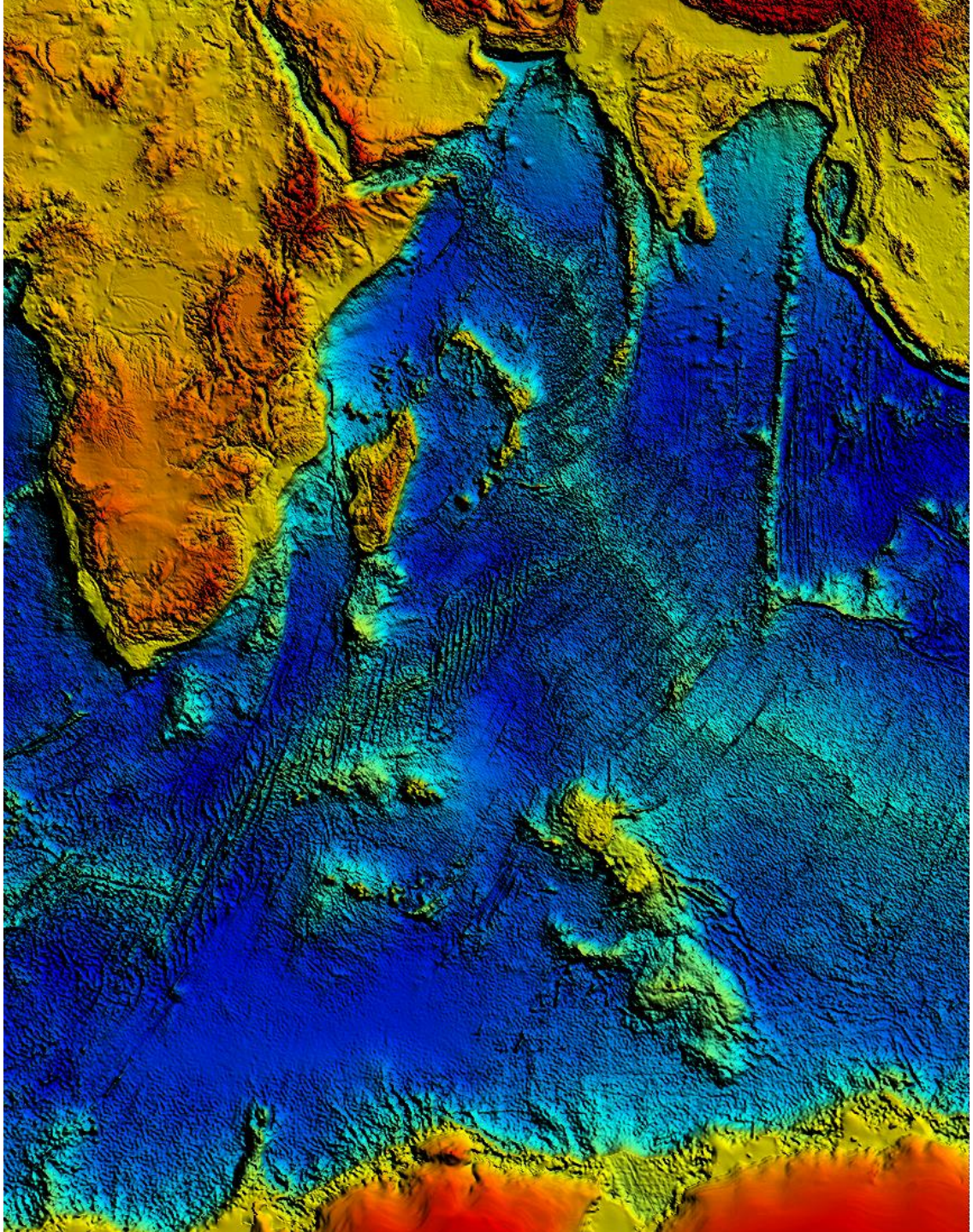





Madagascar, U-Pb Zircon Ages
(R.D. Tucker and colleagues, unpublished data)
Greenstone Belts (Proterozoic)
Greenstone Belts (Archaean)
714.9±1.8 Ma
716.5±2.8 Ma
91.6±0.3 Ma
753.8±1.7 Ma
monazite
519 ±1Ma
2501.9+4/-2 Ma
2513.9±2.0 Ma
779±3 Ma
778.5±2.1 Ma
2518.4+5.2/-4.5 Ma
2521.6+3.6/-2.4 Ma
3187±2 Ma
540-545 Ma
0
100
200 km


Rajasthan, 1999


Belinda van Lente, M.Sc. 2002
Lisa M. Carter, M.Sc. 2005
3. 3. 2002



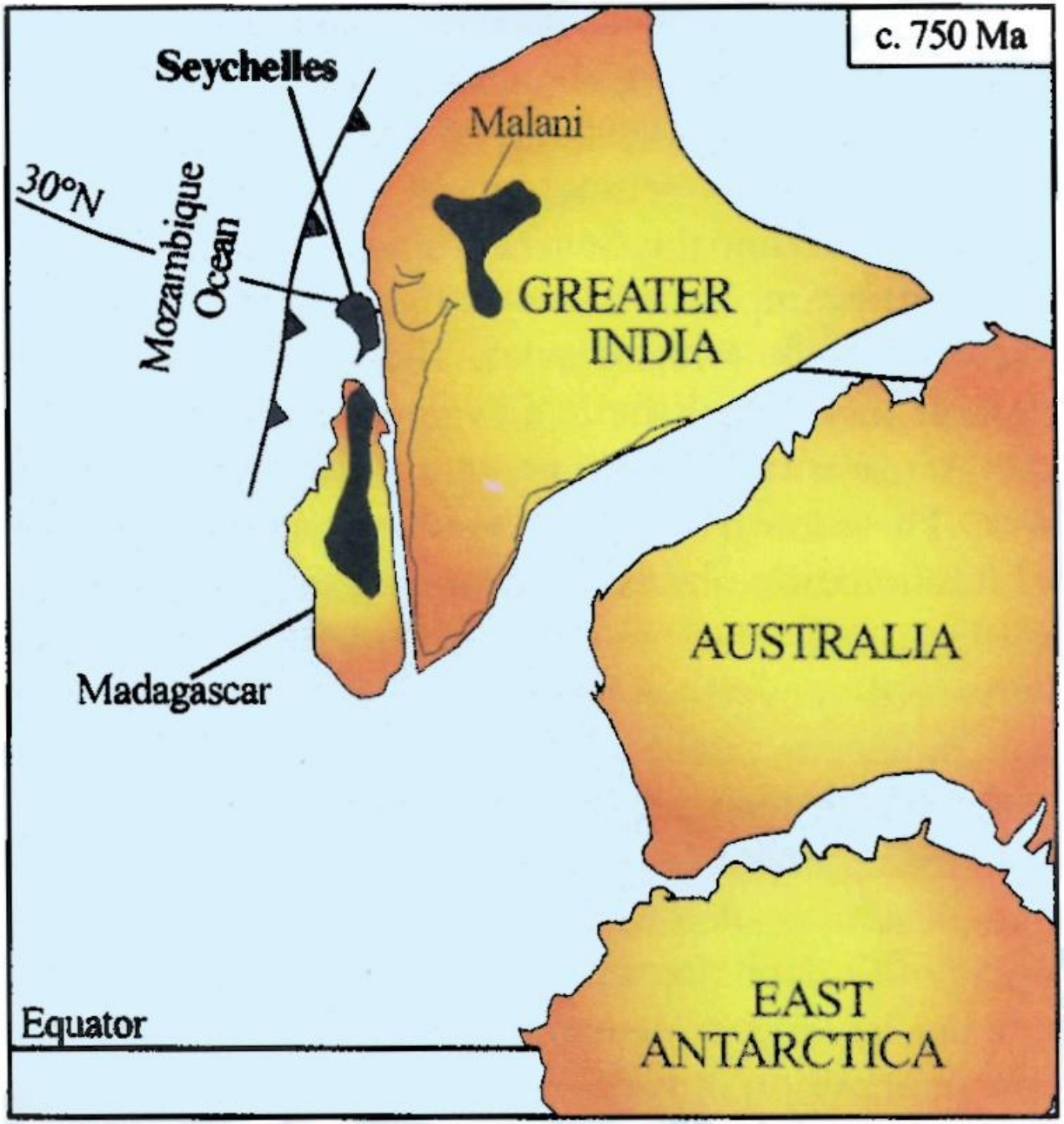



North Island, Seychelles, 1997
UNIVERSITY OF OSLO
EAST GREENLAND
CALEDONIAN
TECTONICS PROJECT

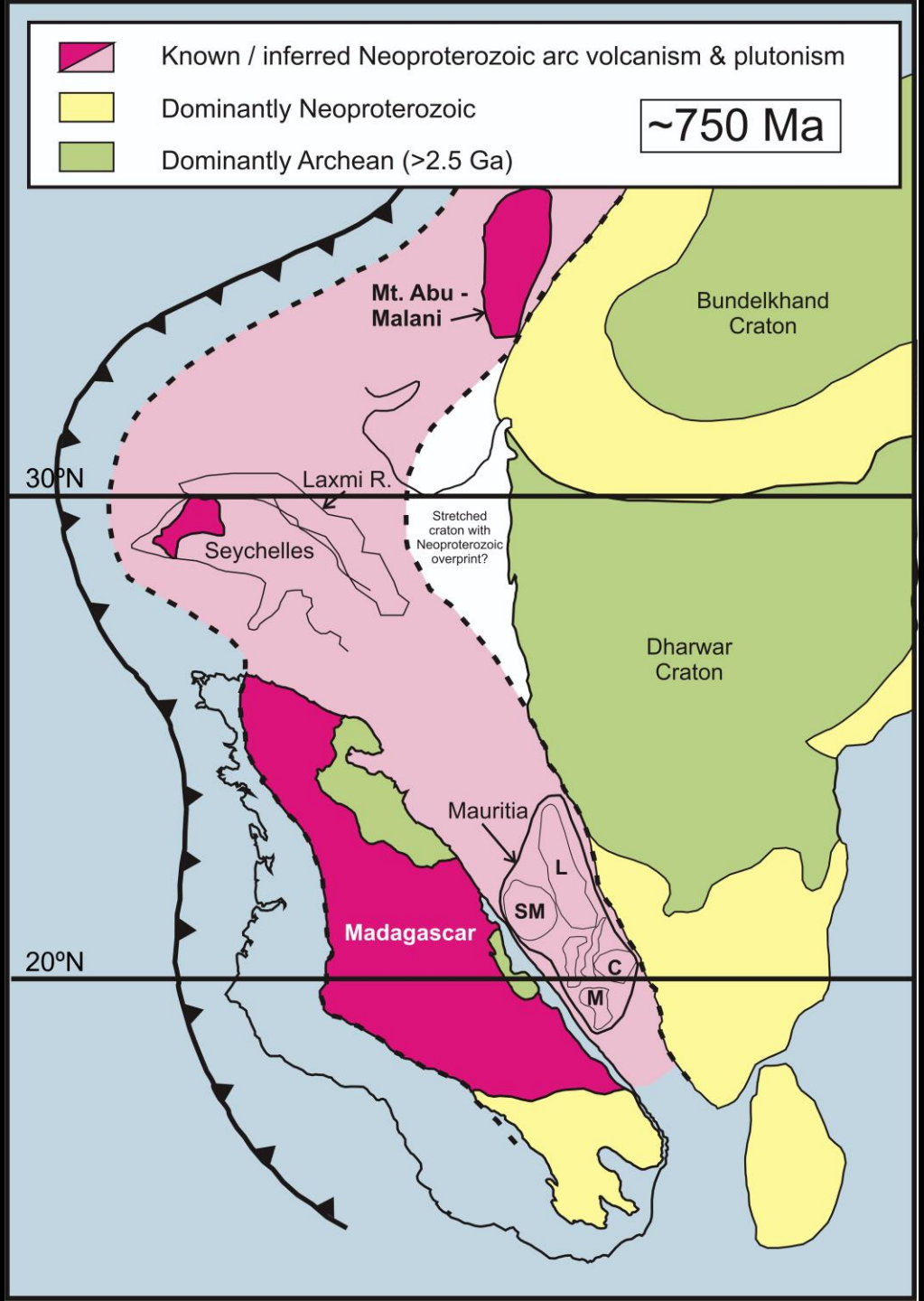


Seychelles:
granite & dolerite, 750 Ma

Rodinia
~750 Ma



After Ashwal *et al*. (2002)

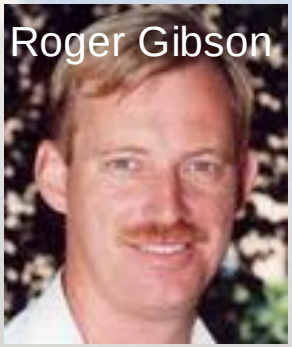


Western Rodinia

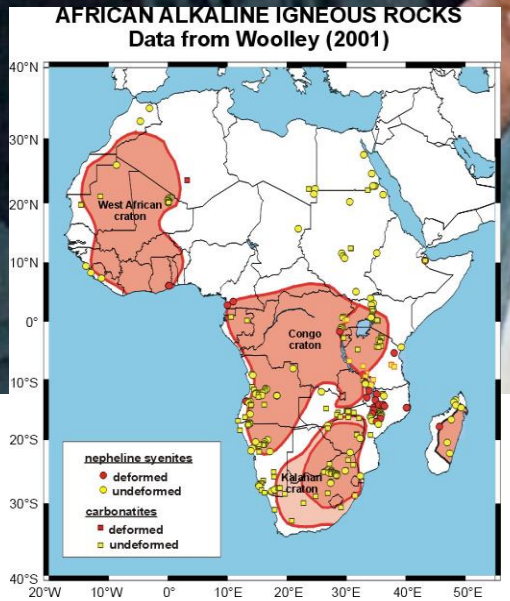
Ashwal et al., in prep


Spike McCarthy

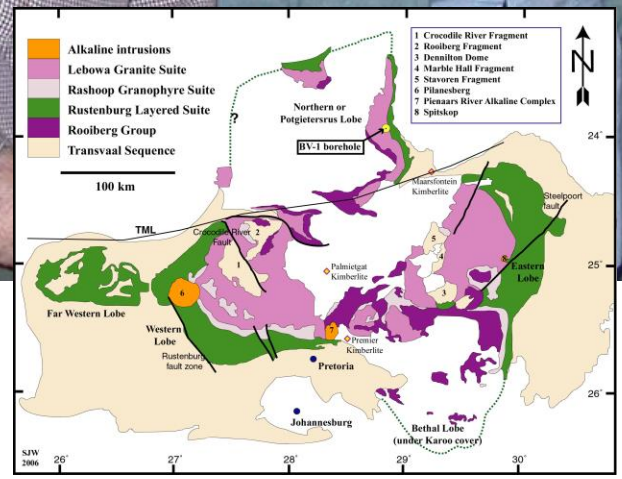

Paul Dirks


Roger Gibson

Madelein Gerber
B.Sc. Hons 2002
M.Sc. 2005



Gabisele V. Simelane
M.Sc. 2004





Madelein Gerber
M.Sc. 2005

R. James Roberts
Ph.D. 2009



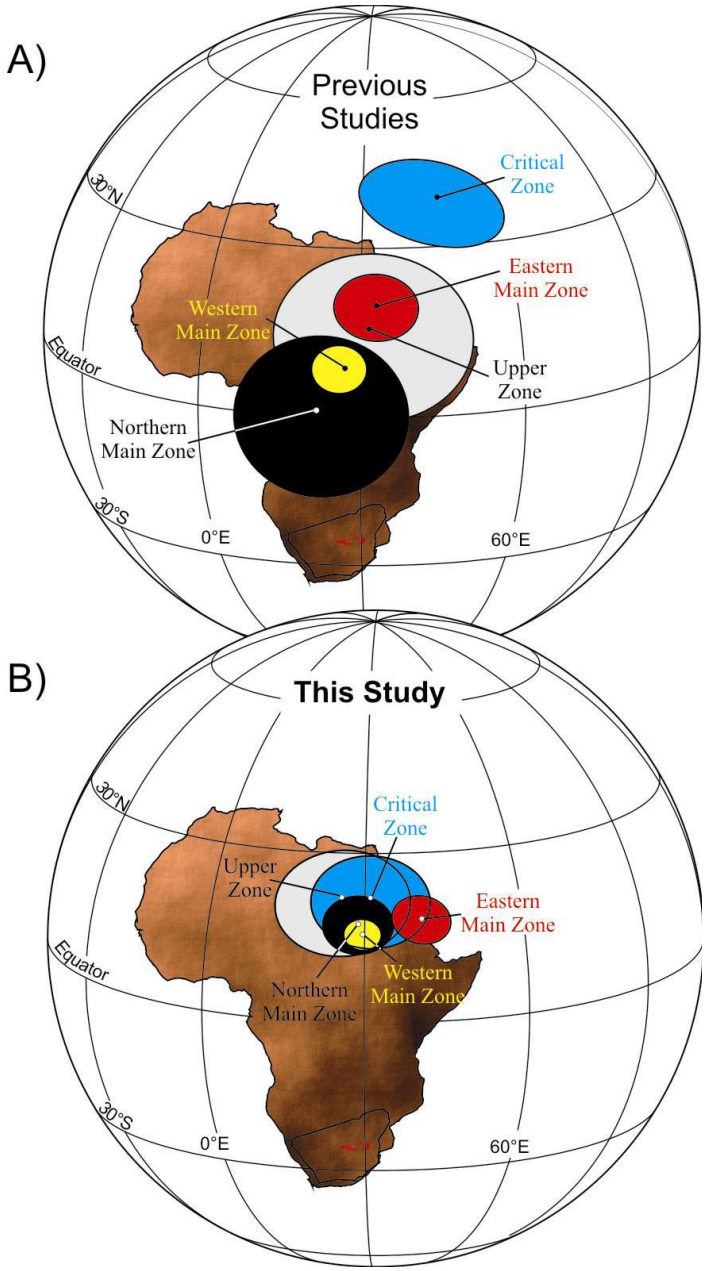


Finnmark, Northern Norway



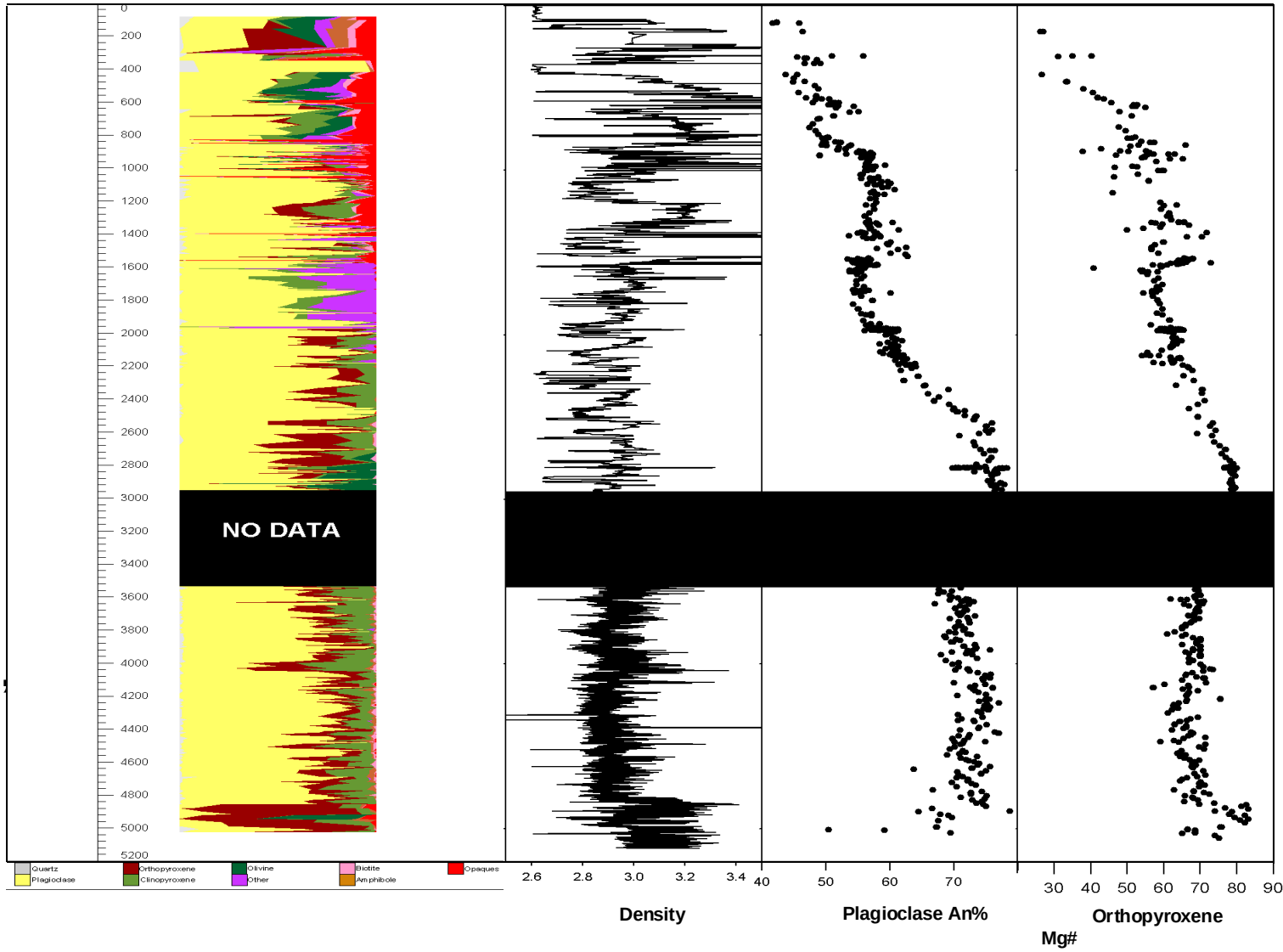
Shawn Letts, Ph.D. 2009



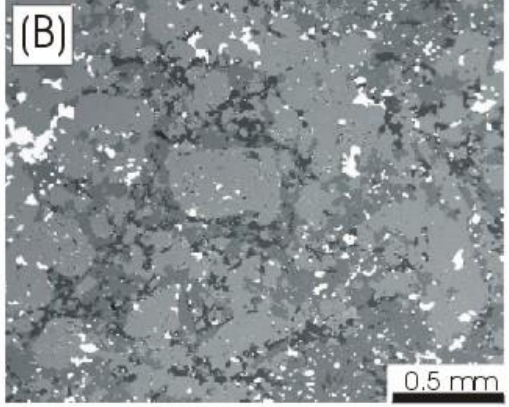




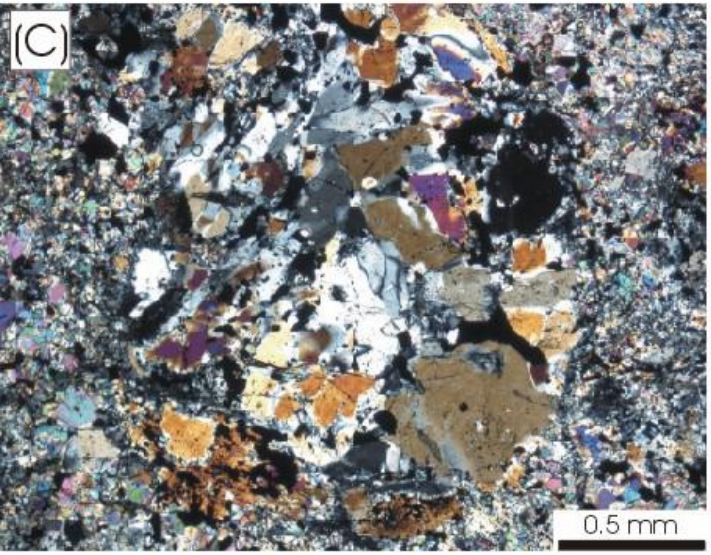
Freddie Roelofse, Ph.D. 2010

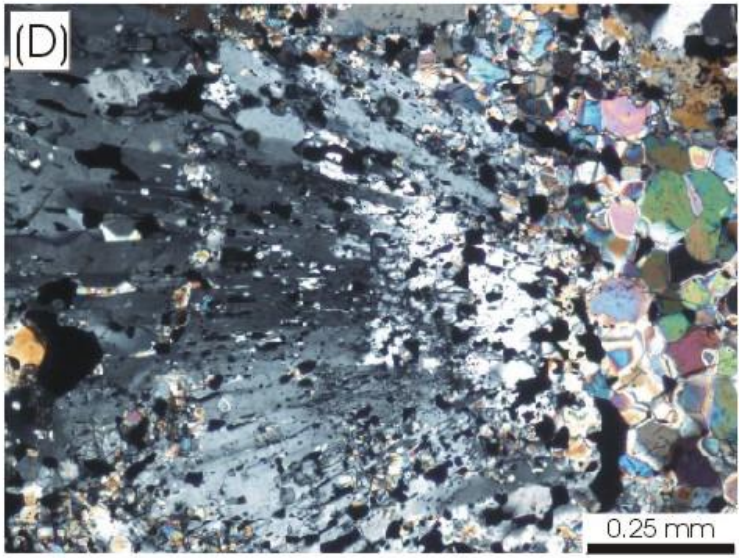






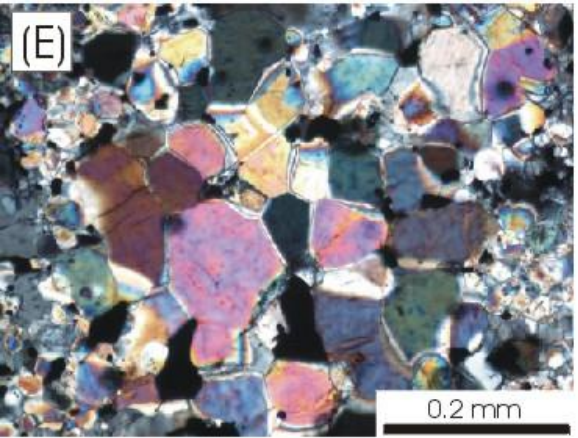
Morokweng meteorite





First report of bolide in impact melt

Maier et al. Nature, 2006







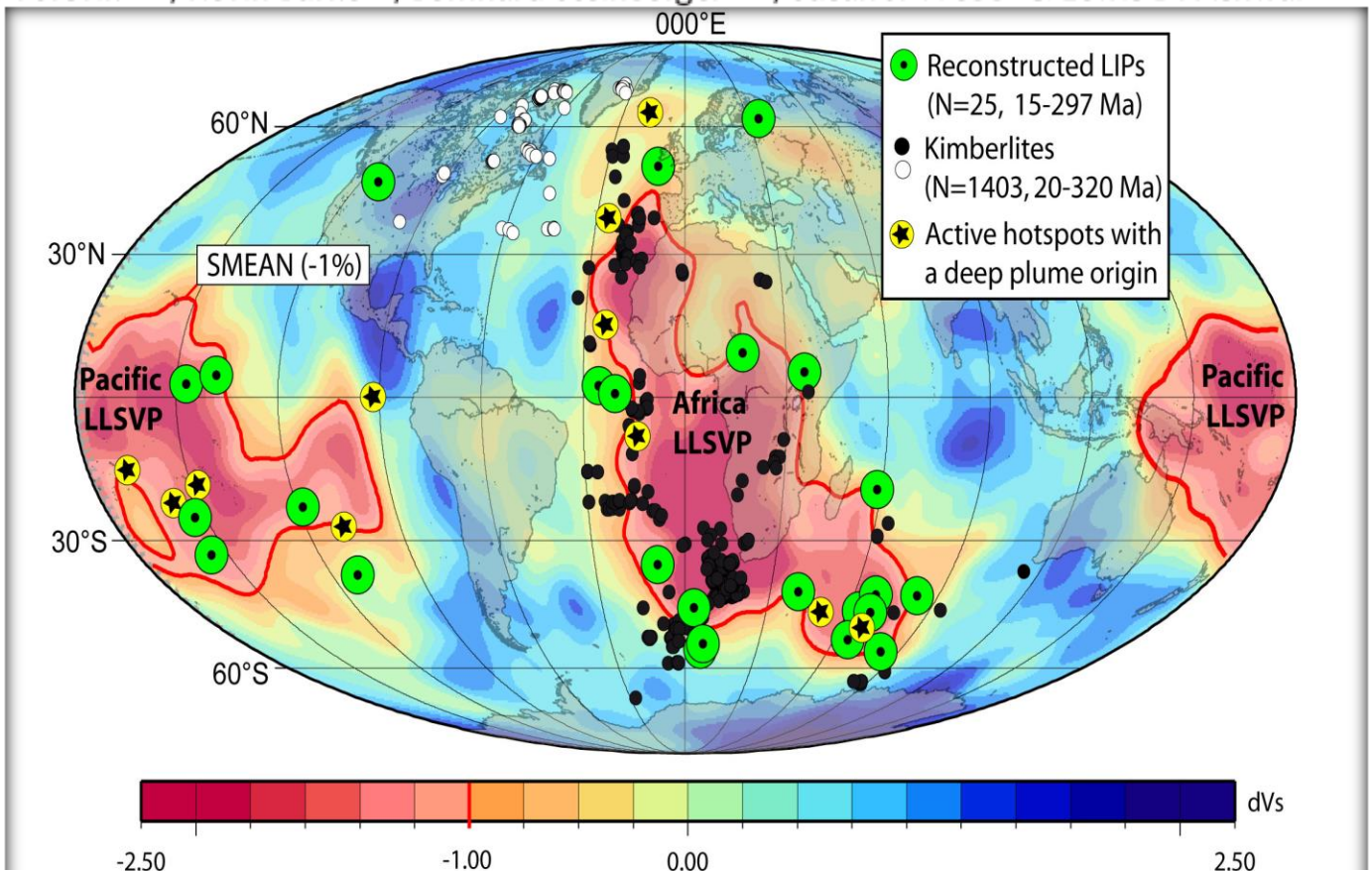
Marco Andreoli

nature Vol 466|15 July 2010|doi:10.1038/nature09216

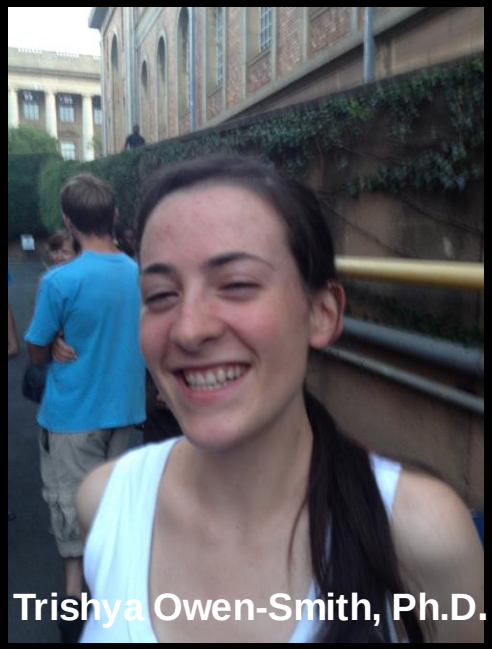
LETTERS

Diamonds sampled by plumes from the core–mantle boundary

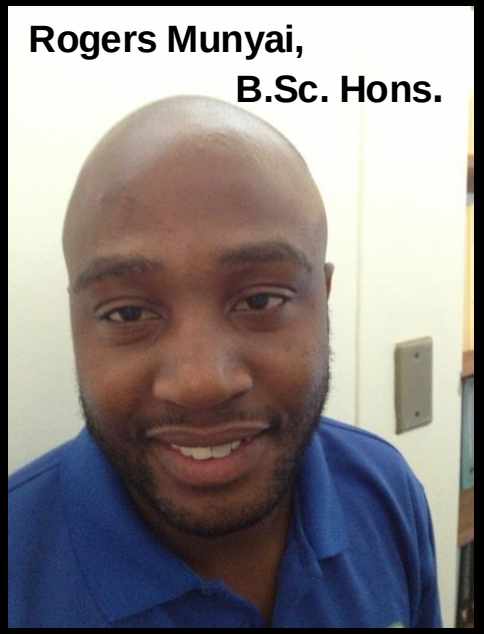
Trond H. Torsvik[1,2,3], Kevin Burke[3,4], Bernhard Steinberger[1,2,5], Susan J. Webb[3] & Lewis D. Ashwal[3]

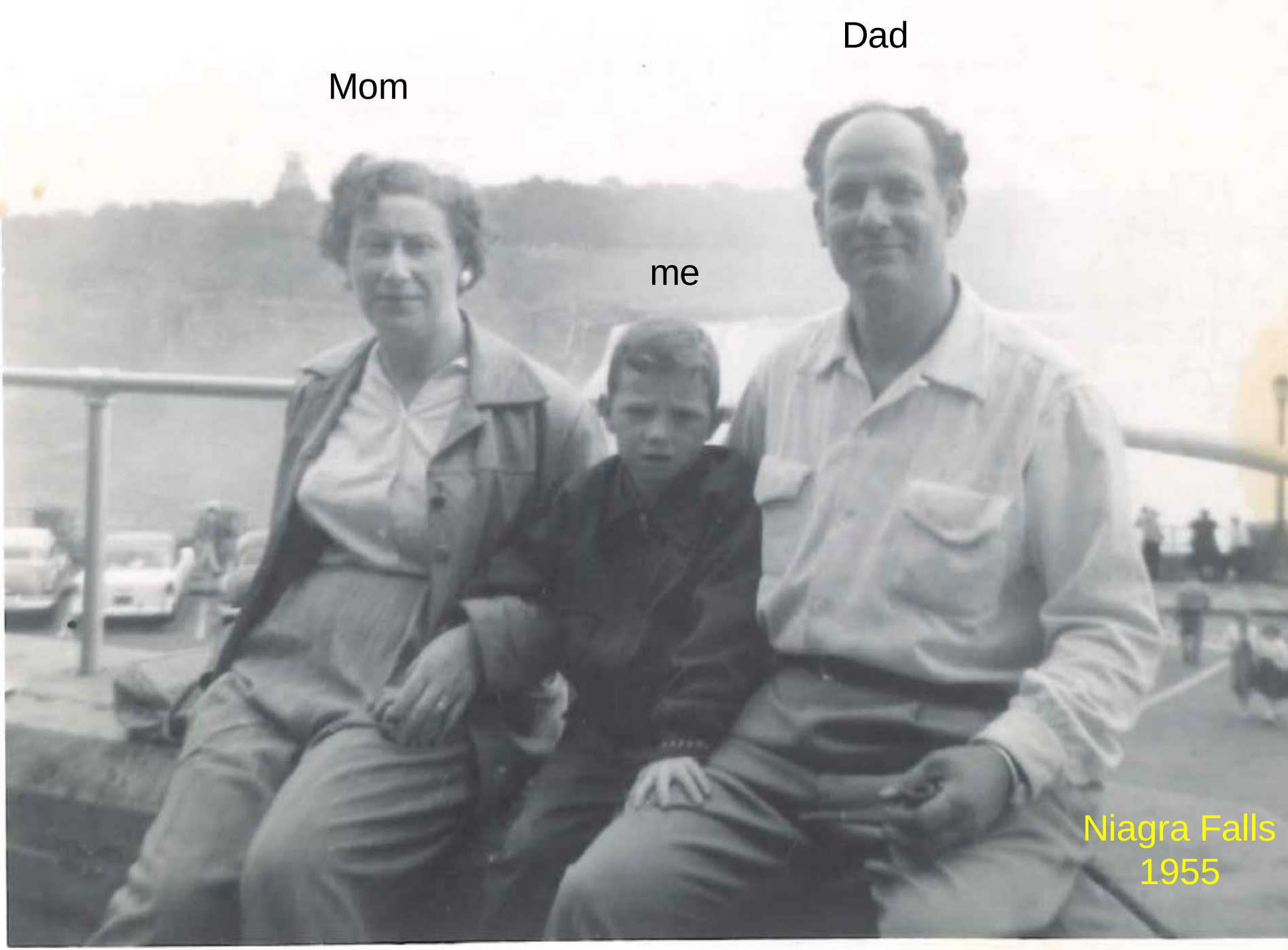


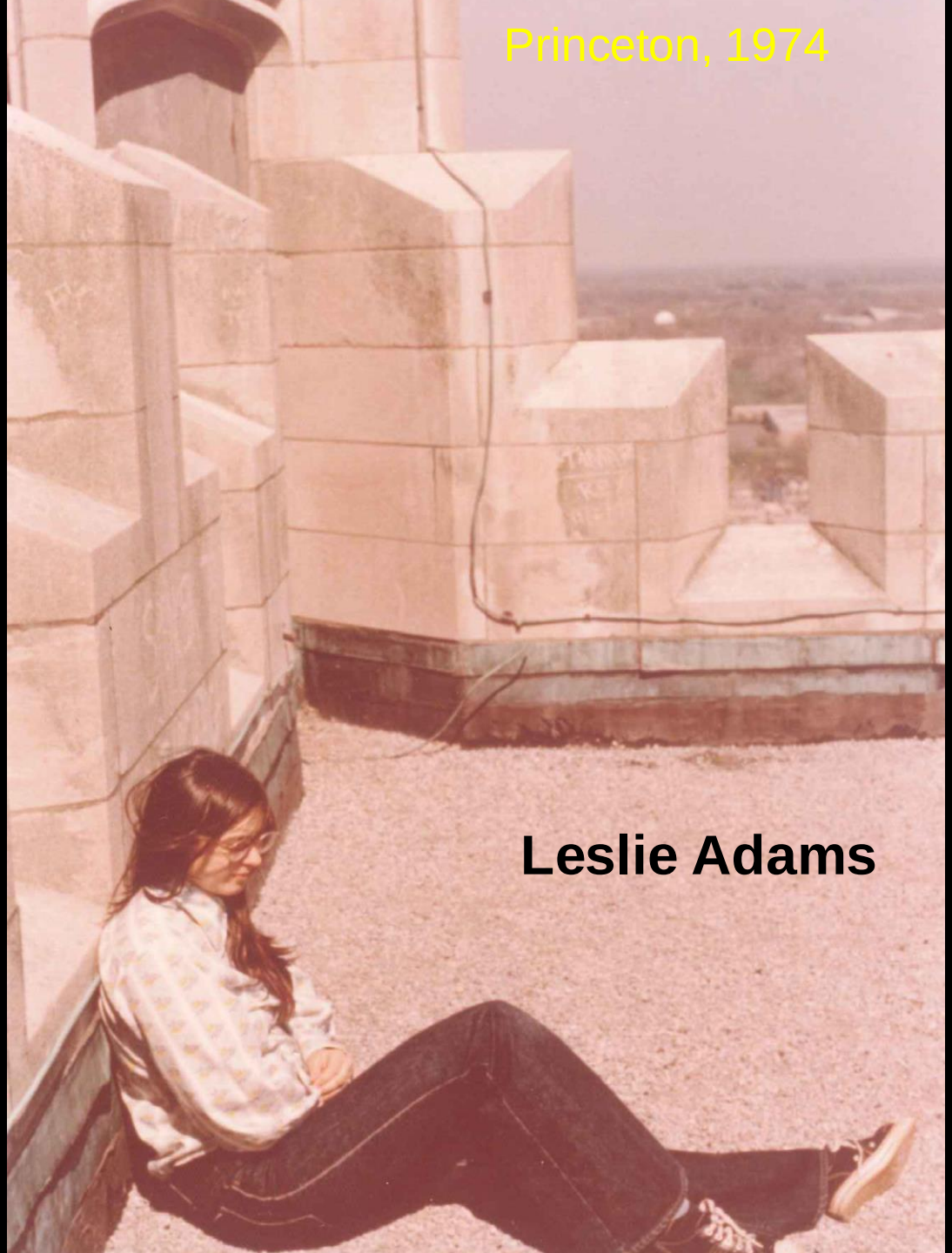

Natalie Deseta, Ph.D.

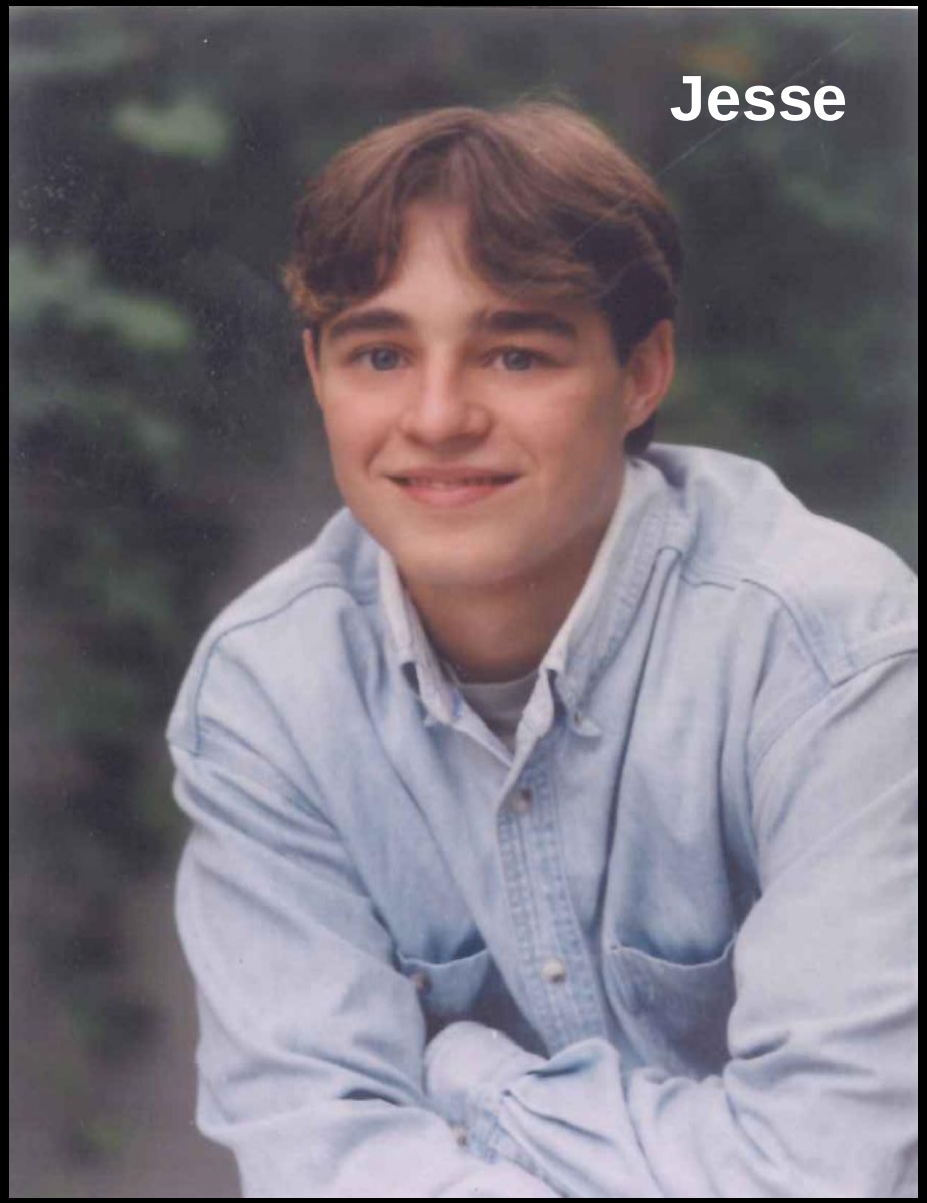

Trishya Owen-Smith, Ph.D.

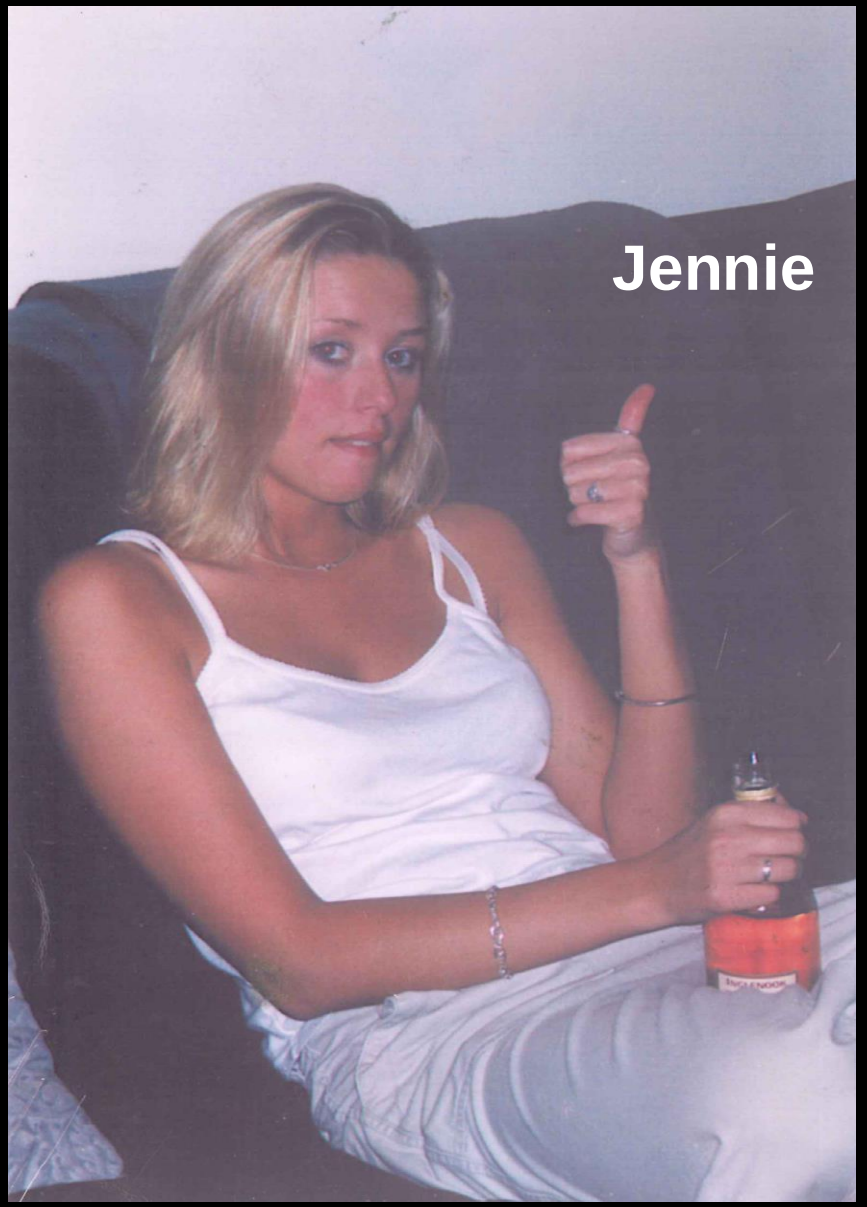

Grant Bybee, Ph.D.


Rogers Munyai,
B.Sc. Hons.


Dad
Mom
me
Niagra Falls
1955


Princeton, 1974
Leslie Adams


Jesse


Jennie


Sam


Ben

SUE !!!!!!!!!!



Financial Support of Research- THANKS !!

New York State
National Research Council (USA)
National Science Foundation (USA)
NASA
University of Massachusetts
Princeton University
Lunar and Planetary Institute
NATO
FRD/NRF (South Africa)
RAU
Wits University
Mellon Foundation
GSSA
Norwegian Research Council
Norwegian Geological Survey

Gold Fields of South Africa
Anglo Platinum
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De Beers
BHPBilliton
Atomic Energy Corporation
Rareco

Thank you!

