

INTRODUCTION

60 slides, four themes



1. Overview of the life and accomplishments of A.M. Macgregor.
2. Archean geology of Zimbabwe – lessons learnt in over 100 years of mapping
3. Our current understanding of the Geological Evolution of the Zimbabwe Craton
 - Previous geochronology
 - Unpublished geochronology (with Bob Nesbitt and with Erika Barton)
 - “Untangling the Stratigraphy” - towards a new Provisional Stratigraphic Table
4. Relevance for the Mineral Endowment of the Zimbabwe Craton

Acknowledgements:

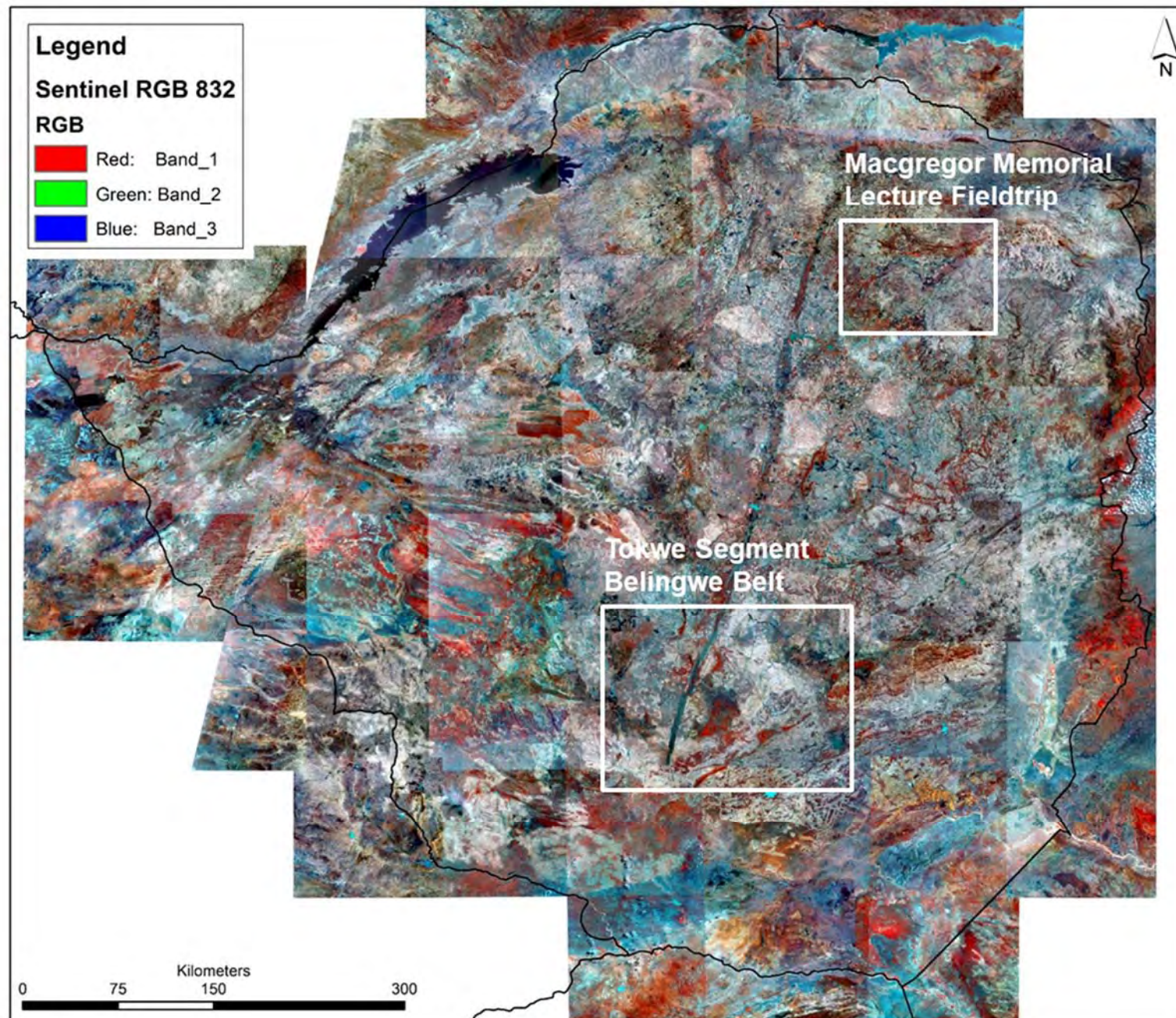
- Brent Barber, Houda Bouammar, Tim Broderick, Tony Martin (Geological Society of Zimbabwe), Forbes Mugumbate (Zimbabwe Geological Survey), Antony Mamuse (Midlands State University), Collins Mwatahwa and Caston Musa (Anglo American Unki Mine), Sharad Master (Wits University), Peter Fey (Consultant), Bob Nesbitt (University of Southampton), Engel Rutherford (Anglo American Group Discovery & Geosciences)
- John Vann (Anglo American Group Discovery & Geosciences); Charles Skinner (De Beers Exploration)

Preparations: Researched literature, scanned historic slides, captured ZGS occurrence data (Bartholomew 1991), compiled and reviewed geochronology data, reflected on own work and of others...

Reference: Fey P (2018). Alexander Miers Macgregor OBE, MA, DSc, FGS. The Geological Survey's third Director 1946-1948. Heritage of Zimbabwe, 37, 69-78.

INTRODUCTION

Satellite Data



Sentinel (832 bands)

A.M. MACGREGOR (OBE, MA, DSc, FGS)

Rare photo of A.M. Macgregor with Frank Dixey over tea at the courtyard of the Geological Survey during the 1955 CCTA meeting of African Geological Surveys held at Town House.



Photo courtesy of Tim Broderick

A.M. MACGREGOR



- A truly remarkable man
- Alexander Miers Macgregor was born in London in 1888 and died in Bulawayo in 1961.
- He was a knowledgeable man, passionate about geoscience, and devoted his life to geological mapping.
- He was interested in fossils from a young age, encouraged by his father, a sculptor.
- He graduated with a BA degree from Queen's College in Cambridge in 1911.
- In 1912 he was appointed as geologist and assistant curator at the Bulawayo Museum.
- He joined the Geological Survey in 1915 which was then directed by Herbert Maufe and assisted in mapping the Karoo rocks and younger sediments north-west of Bulawayo.
- He completed the work in 1916 and erected a new group, the Kalahari System.
- He enlisted in the army in the same year, rose to the rank of Lieutenant, and saw active military service in France and Flanders during World War 1.
- In 1919 he returned and started a 27-year marathon of field work.
- He married in 1923 and the couple had two sons and a daughter; both sons died over Germany during World War 2.

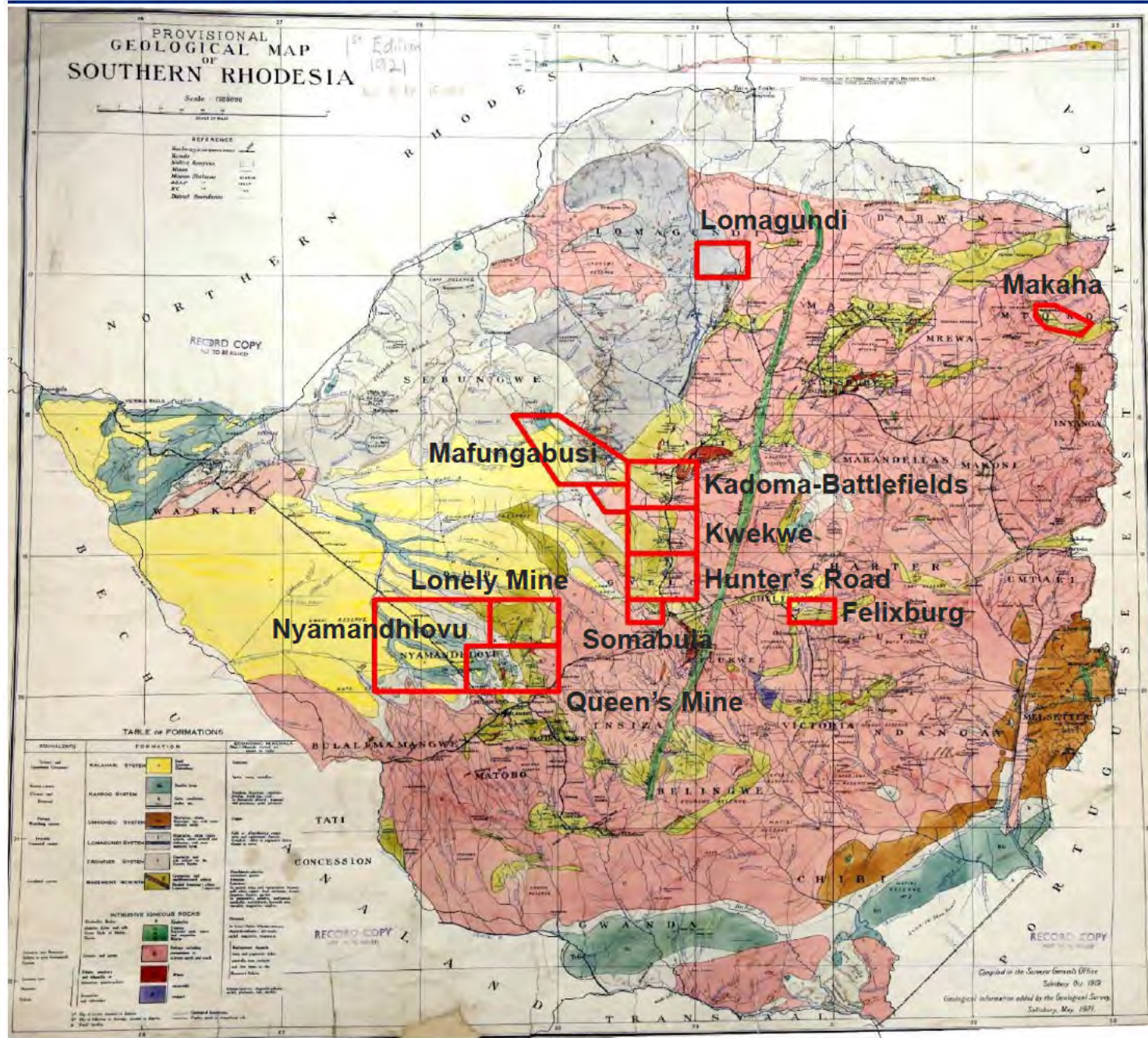
A.M. MACGREGOR



- He completed the late Zeally's mapping of the Somabula diamond field (1921) before returning to Bembezi Valley to complete his own mapping around Lonely Mine in 1923.
- Maufe and Macgregor conducted a reconnaissance survey of the country to compile the 1st edition of the 1: 1 million geological map of the country which was published in 1921.
- He subsequently described the geology of the gold belts and mines, and worked his way south from Kadoma through Battlefields and Kwekwe to Hunters Road.
- The work resulted in his famous tripartite subdivision of greenstone belt stratigraphy into the Sebakwean, Bulawayan and Shamvaian Groups, a broad framework still accepted.
- He was the first to map and describe rocks which became known as komatiite.
- His efforts produced 8 Bulletins and 7 Short Reports covering ~12,000 km² (120 months)
- He had a wide range of geological interests, just like Alex du Toit, with whom he corresponded and he published on a range of topics such as Palaeolithic implements, the Precambrian atmosphere, stromatolites, fossil reptiles, "The Influence of Life on the Face of the Earth" and "Gregarious Batholiths".

A.M. MACGREGOR

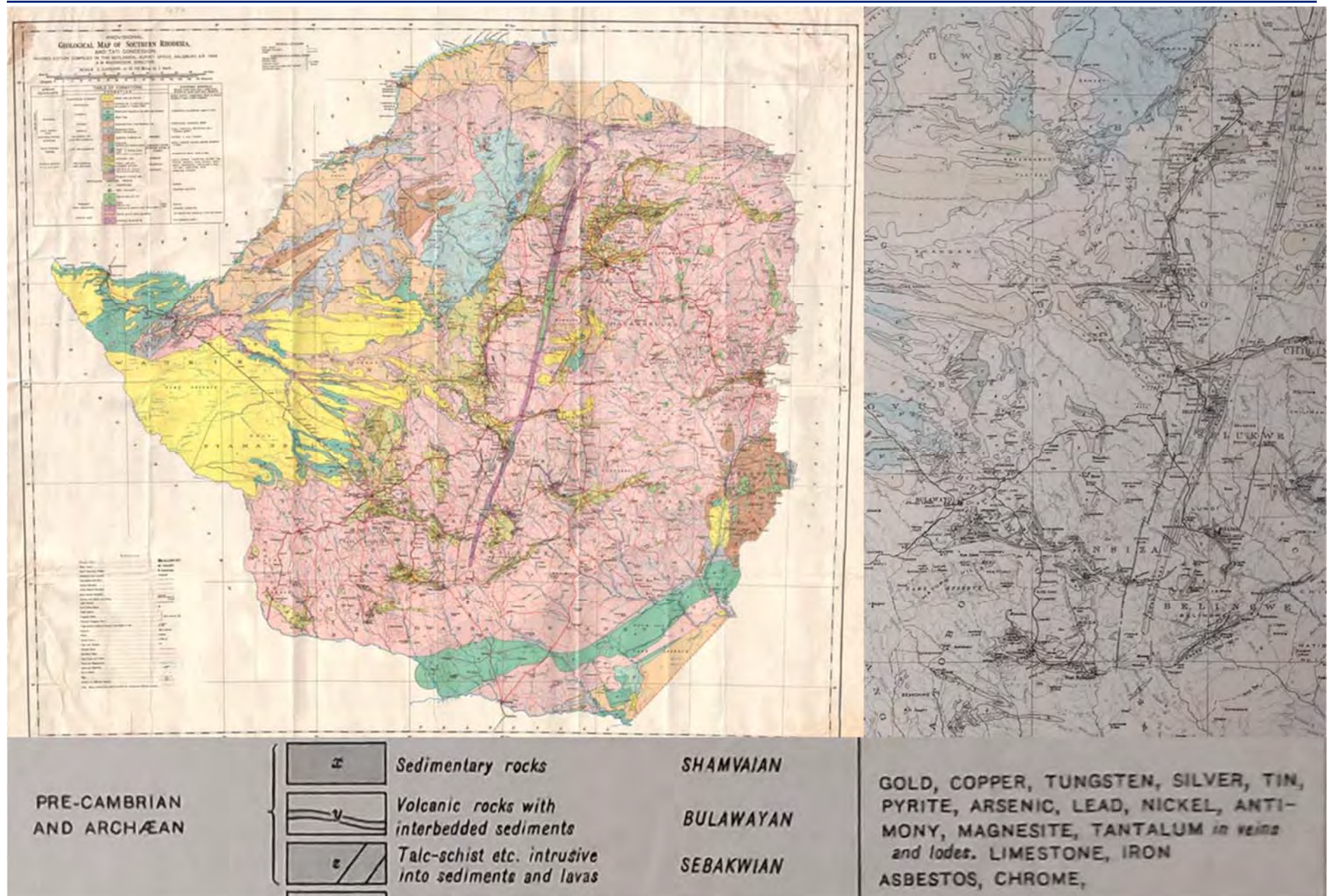
Maufe and Macgregor (1921), 1st Edition



1st Edition
1921
Not to be issued

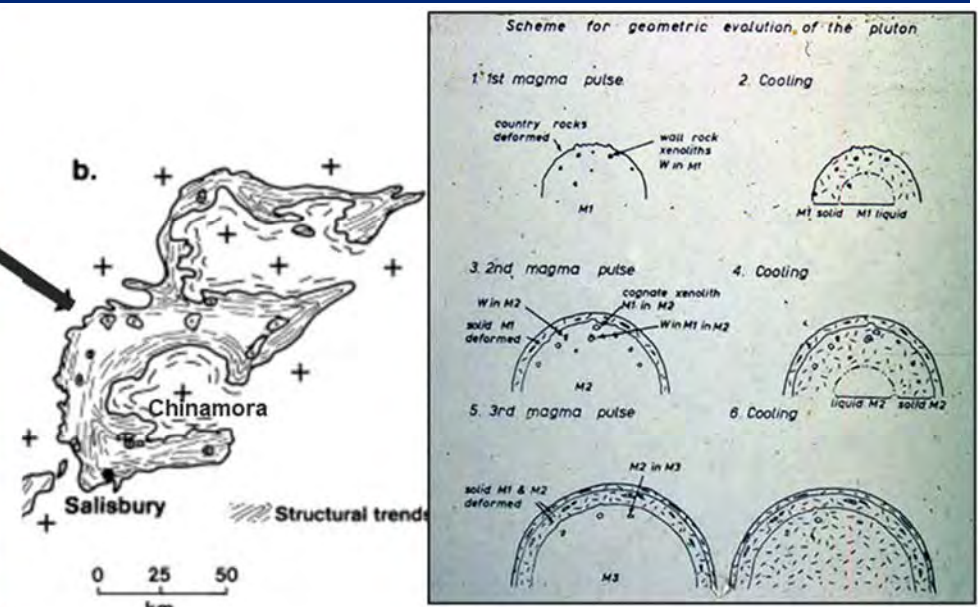
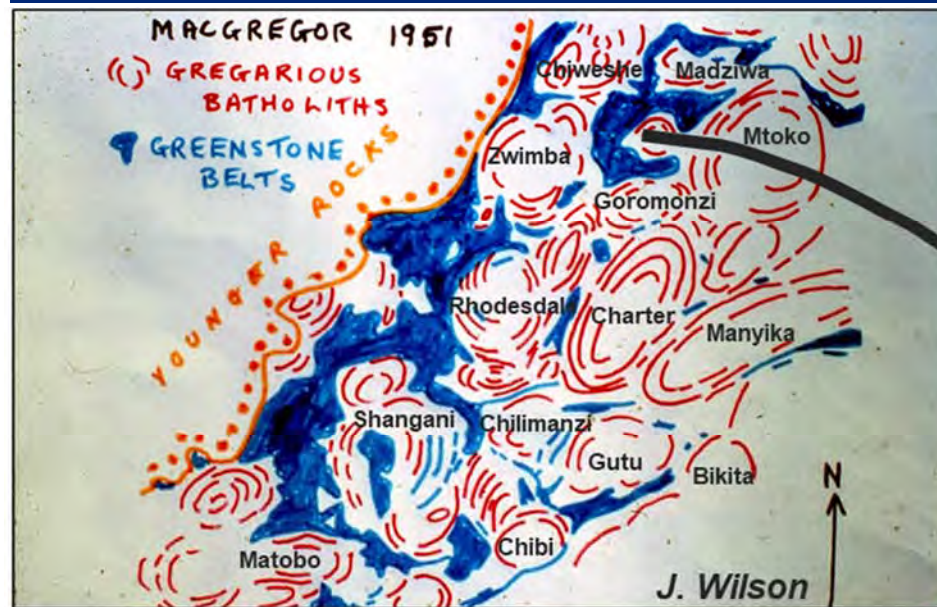
A.M. MACGREGOR

Macgregor (1946), 4th Edition



A.M. MACGREGOR

“Gregarious Batholiths”



The Chinamora Batholith **diapiric intrusion or interference fold?**

P. A. SNOWDEN and M. J. BICKLE
Journal of the Geological Society, 132, 131-137, 1 March 1976, <https://doi.org/10.3144/gsjgs.132.2.0131>

1976

Emplacement kinematics of a **granite diapir**: the Chinamora batholith, Zimbabwe

John G Ramsay
Journal of Structural Geology
Volume 11, Issues 1-2, 1989, Pages 191-209

1989

ELSEVIER
Journal of Structural Geology
Volume 15, Issue 2, February 1993, Pages 163-176

Tectonic evolution of the Bindura-Shamva greenstone belt (northern Zimbabwe): Progressive deformation around **diapiric batholiths**

H.A. Jelsma, P.A. van der Beek, M.L. Vinyu

1993

4.2

Relations Between Greenstone Belts and Associated Granitoids

J.R. Ridley, J.R. Vearncombe, and H.A. Jelsma

1997



PERGAMON

Journal of Structural Geology 22 (2000) 1837-1853

JOURNAL OF
STRUCTURAL
GEOLOGY

www.elsevier.nl/locate/jstrugeo

The **Chinamora batholith** Zimbabwe: structure and emplacement-related magnetic rock fabric

J.K. Becker^{a,*}, S. Siegesmund^a, H.A. Jelsma^b

2000

Transtensional tectonics for the 2575Ma Great Dyke and diachronous Razi-Chilimanzi suite plutonism **the end of Macgregor's vertical tectonics** ?

Mark Tsomondo

2017

A.M. MACGREGOR

“Gregarious Batholiths”: Chinamora



A.M. MACGREGOR



- Macgregor became the 3rd director of the Geological Survey in 1946 (after Herbert Maufe and Ben Lightfoot).
- The 4th edition of the 1: 1 million geological map of the country was published in 1946.
- He was awarded the degree of Doctor of Science by the University of Natal in 1947 for his work on the geology of the country, which comprised of over 50 publications.
- He was awarded the Geological Society of South Africa Draper Memorial Medal in 1947, the highest award of the Geological Society of South Africa.
- He was honoured the OBE in 1949 for his significant impact on geology.
- He served on the council of the Geological Society of South Africa from 1947 to 1955.
- He became the Society President in 1951. His presidential address 'Some milestones in the Precambrian of Southern Rhodesia' was a major contribution to our heritage.
- After his retirement in 1948 he consulted to the mining industry until 1956.
- He was engaged from 1954 by Anglo American Corporation to start their local office.
- In 1966, after his death, the Geological Survey named its refurbished museum after him.

A.M. MACGREGOR

Geological Survey staff (1948), with Macgregor and 4 future directors shown



Circled:

Stagman

Director 1976-1978
7th edition (1978)

Worst (Great Dyke)

Lamont (Orapa)

Wiles

Director 1967-1976
6th edition (1971)

Amm

Director 1960-1962
5th edition (1962)

Ferguson

Director 1948-1960

Macgregor

Director 1946-1948
1st edition (1922)
4th edition (1947)

Tyndale- Biscoe

Photo courtesy of Tim Broderick. Back row L-R: J.G. Stagman, B.G. Worst, V.L. Barnes, W.H. Swift, W.C. White, G.T. Lamont, J.W. Wiles.
Middle row L-R: N.E. Barlow, Miss M.E. Peckover, V.E. Horne, Miss D.C. M. McIntosh, D.O.L. Levy, Mrs J.M. Lloyd, B.B. Napier.
Front row L-R: F.L. Amm, J.C. Ferguson, A.M. Macgregor (Director), R.M. Tyndale- Biscoe, E. Golding. Absent: A.E. Phaup, Miss J.M. Laing

A.M. MACGREGOR



- He was a modest and erudite man
- He is to be remembered for his enormous contribution to geology.
- His maps changed the course of geological thinking in southern Africa and impacted on our understanding of mineral endowment and the discovery of mineral deposits.
- His quiet enthusiasm was infectious.

**His passion and determination in mapping and documenting field observations is to be continued,
which is the cornerstone of investigations in our field.**

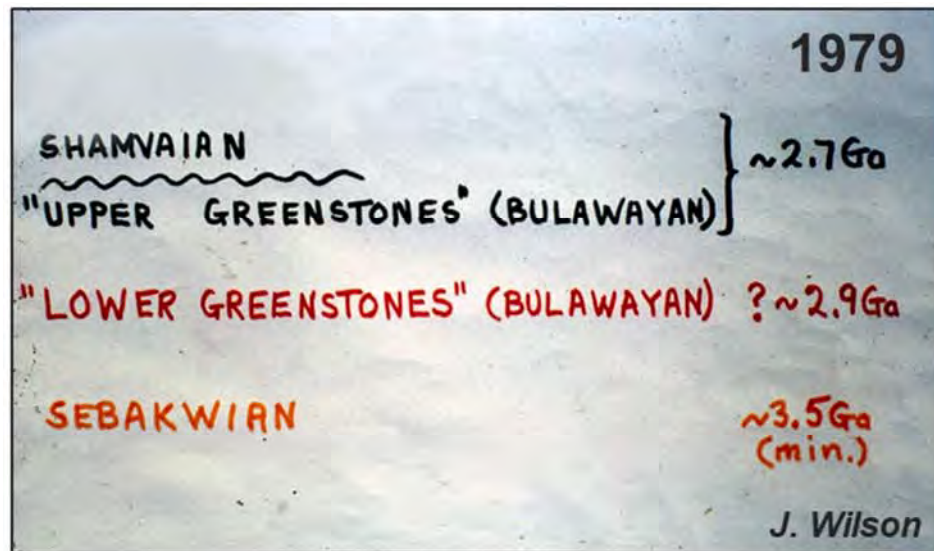


Archaean of Zimbabwe

- “Recent developments of methods for determining the age of rocks by radioactivity bring the time near when a world-wide nomenclature of Precambrian eras comparable with the classification of fossiliferous rocks should be considered.”
- *A.M. Macgregor 1951 Presidential address to the Geol. Soc. S. Africa.*

ARCHEAN GEOLOGY OF ZIMBABWE

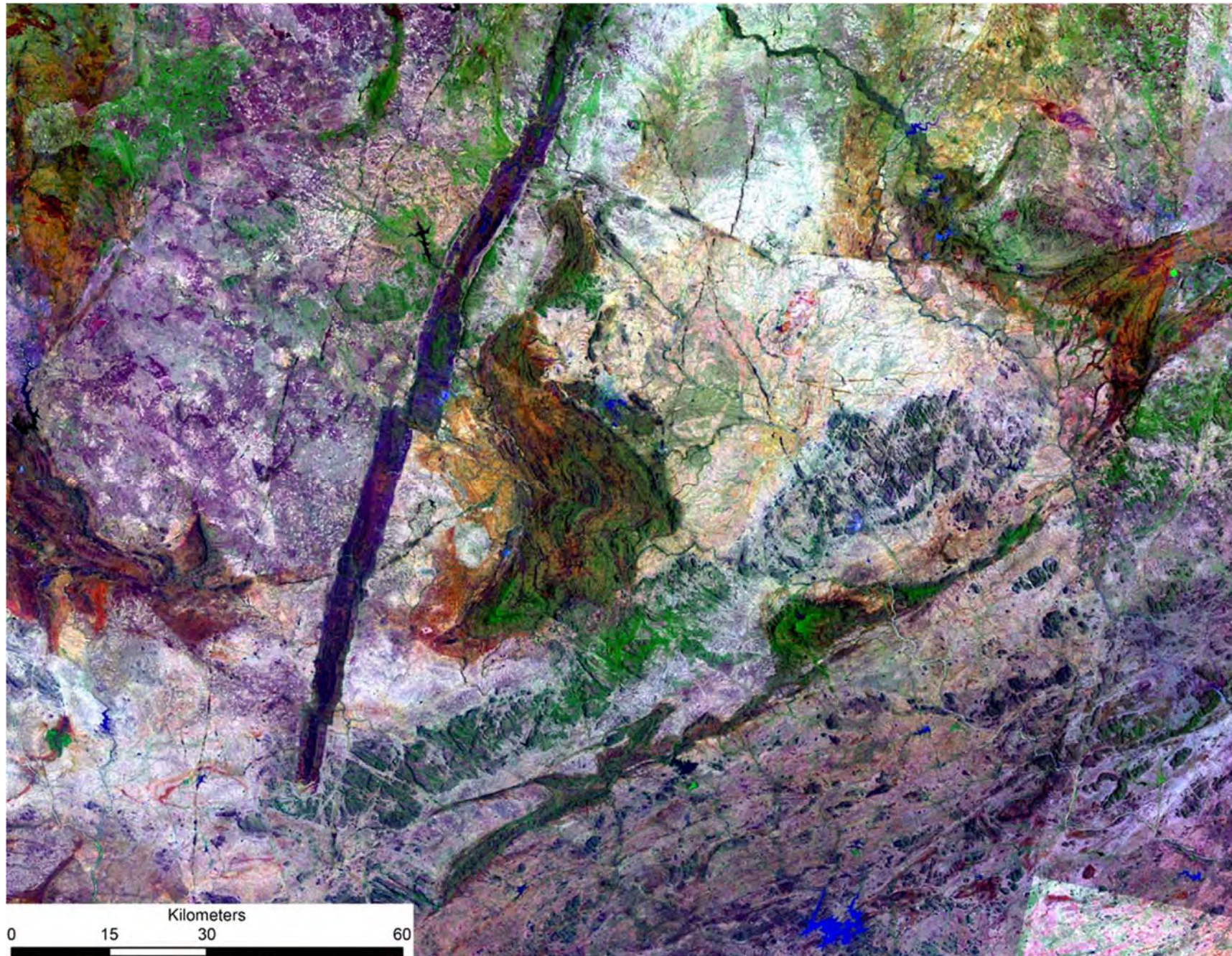
Tripartite Subdivision of Greenstone Belt Stratigraphy: Wilson et al. 1978; Wilson 1979



Wilson 1979	Great Dyke	Shamvaian Group	(Maliyami)	Cheshire	Zeederbergs	Reliance	Manjeri	Manjeri marker	Koodoovale	K marker	Bend	B marker	Hokonui	Sebakwian Group
			Upper Greenstones						Lower Greenstones					
Stagman 1978	Great Dyke	Shamvaian Group	Bulawayan Group											Sebakwian Group
			Upper Bulawayan						Lower Bulawayan					
Macgregor 1947, 1951		Upper Series Shamvaian System clastic deposits	Lower Series Bulawayan System mafic-felsic											Magnesian System Sebakwian System

ARCHEAN GEOLOGY OF ZIMBABWE

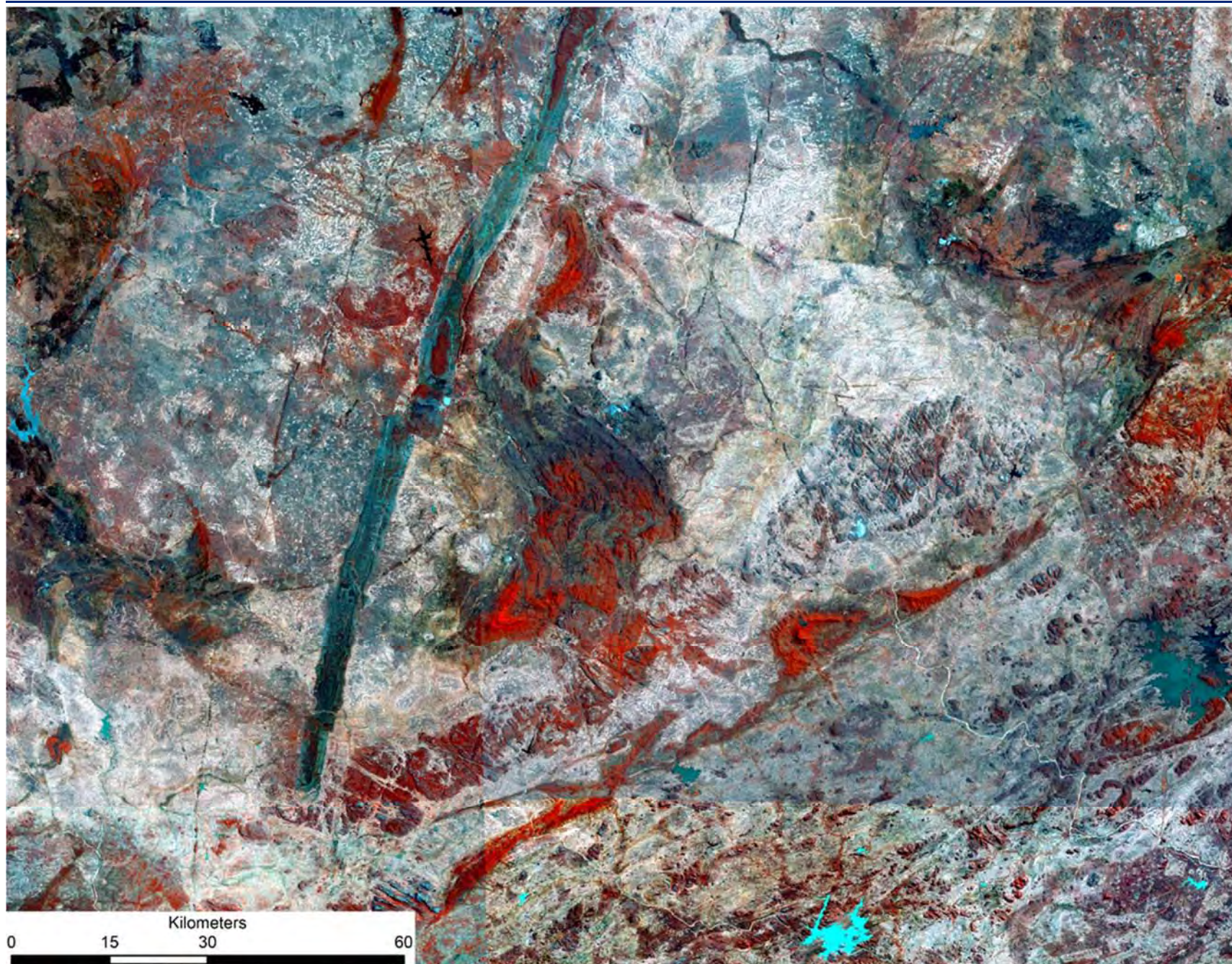
Basement Complex of southern Zimbabwe



Landsat 8
(752 bands)

ARCHEAN GEOLOGY OF ZIMBABWE

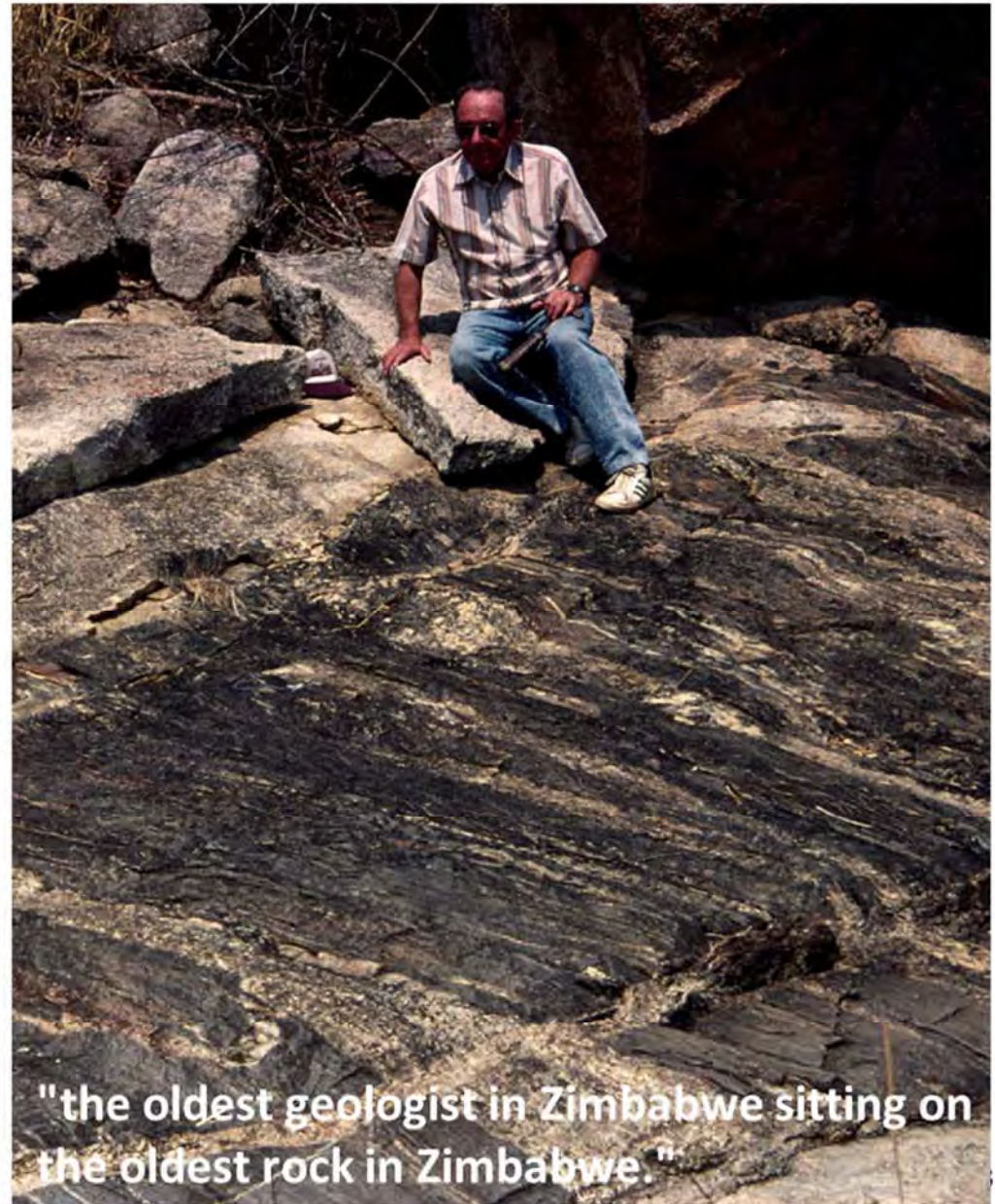
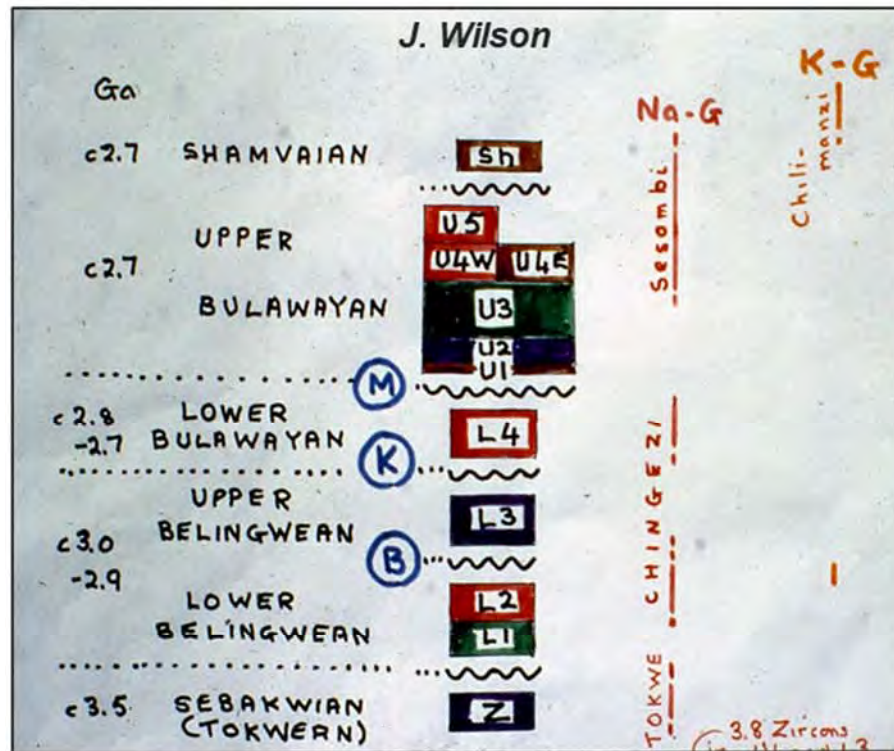
Basement Complex of southern Zimbabwe



Sentinel
(832 bands)

ARCHEAN GEOLOGY OF ZIMBABWE

Wilson et al. 1995: establishing a craton-wide greenstone stratigraphy



"the oldest geologist in Zimbabwe sitting on the oldest rock in Zimbabwe."

Zircon geochronology of Archaean felsic sequences in the Zimbabwe craton: a revision of greenstone stratigraphy and a model for crustal growth

JAMES F. WILSON¹, ROBERT W. NESBITT² & C. MARK FANNING³

¹Department of Geology, University of Zimbabwe, PO Box MP 167, Mount Pleasant, Harare, Zimbabwe

²Department of Geology, The University, Southampton SO17 1BJ, UK

³Research School of Earth Sciences, ANU Canberra, ACT, Australia

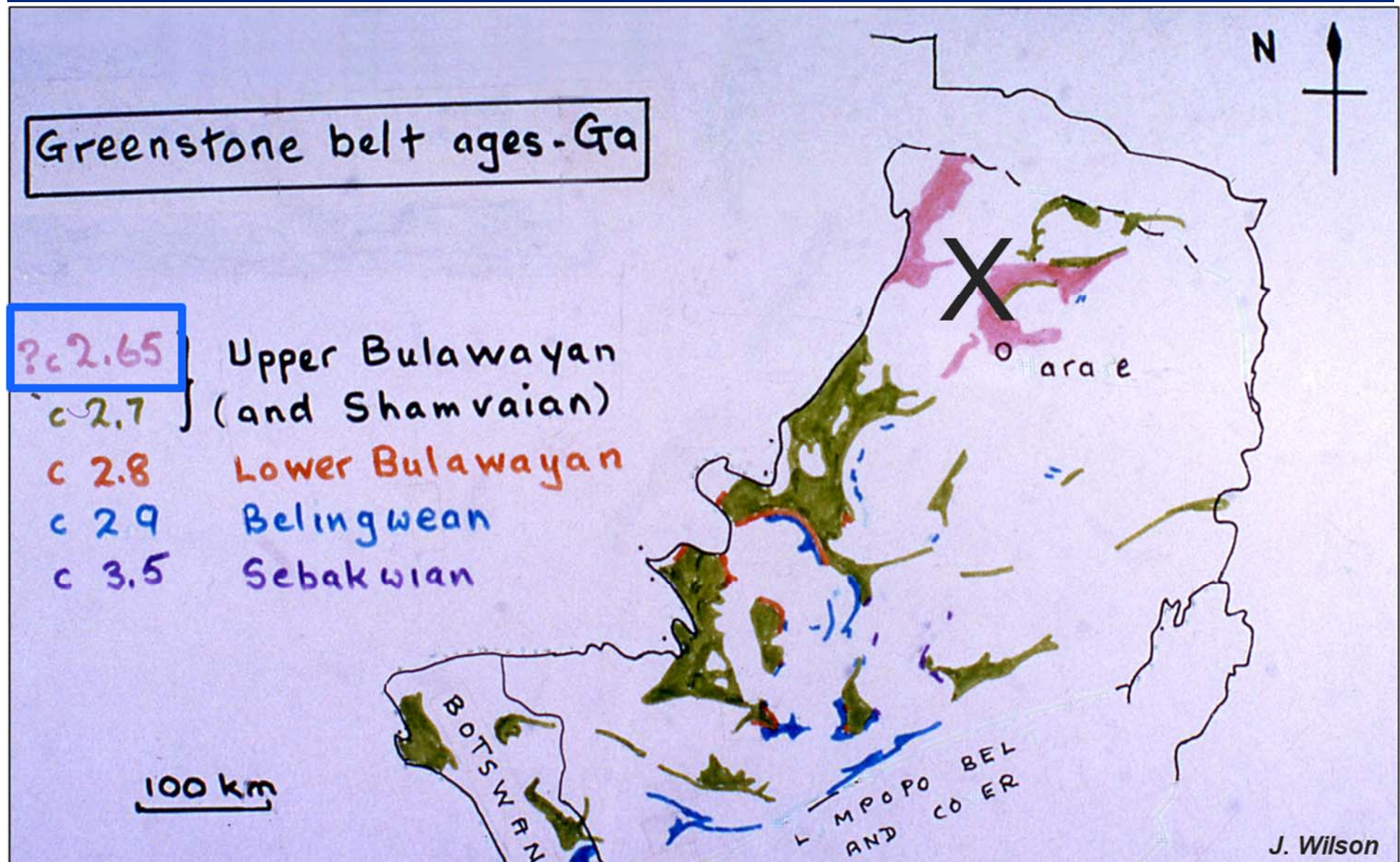
From COWARD, M. P. & RIES, A. C. (eds), 1995, *Early Precambrian Processes*, Geological Society Special Publication No. 95, pp. 109–126

109
1995

Photo of the late Jim Wilson, courtesy of Bob Nesbitt

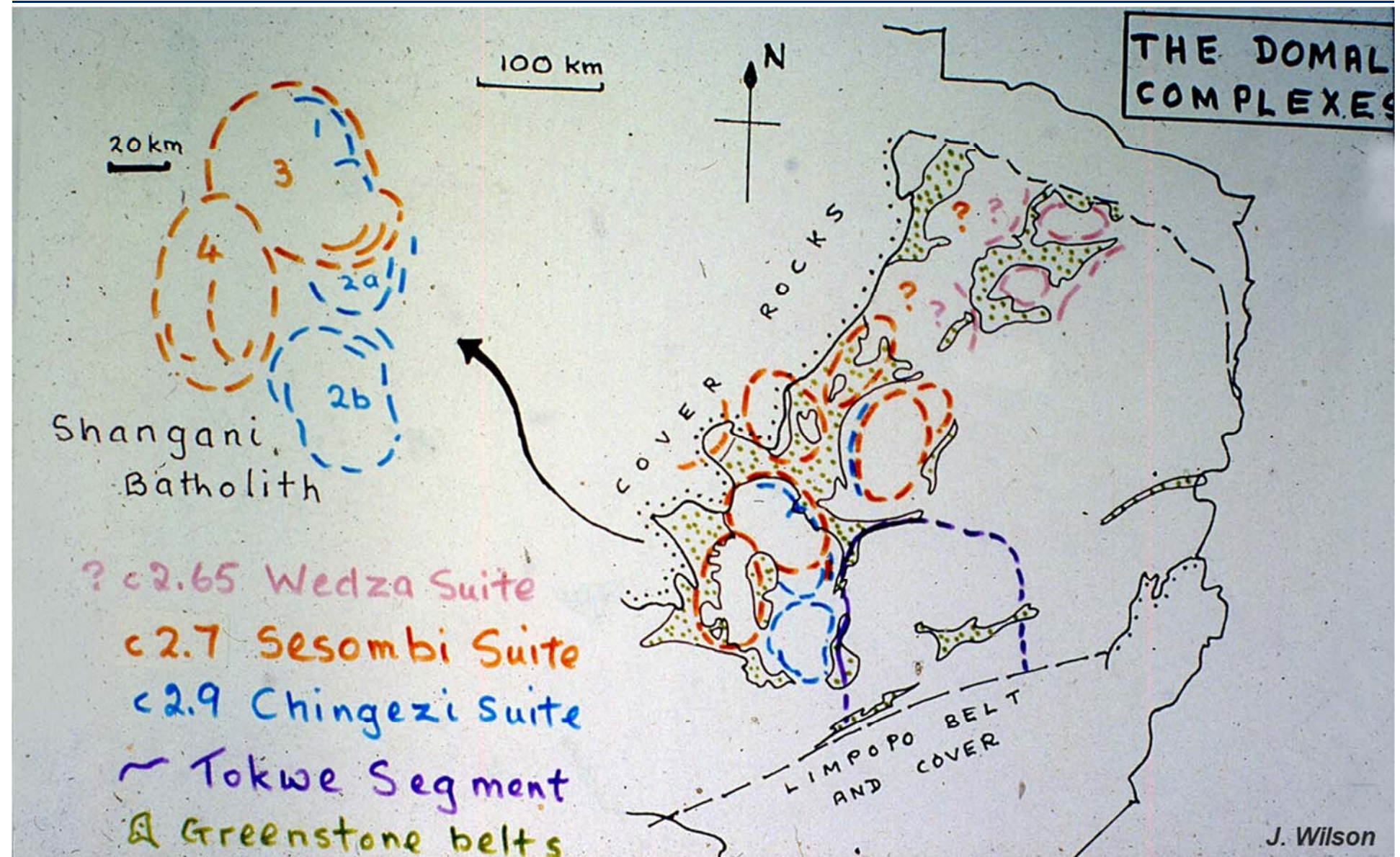
ARCHEAN GEOLOGY OF ZIMBABWE

Wilson et al. 1995: establishing a craton-wide greenstone stratigraphy



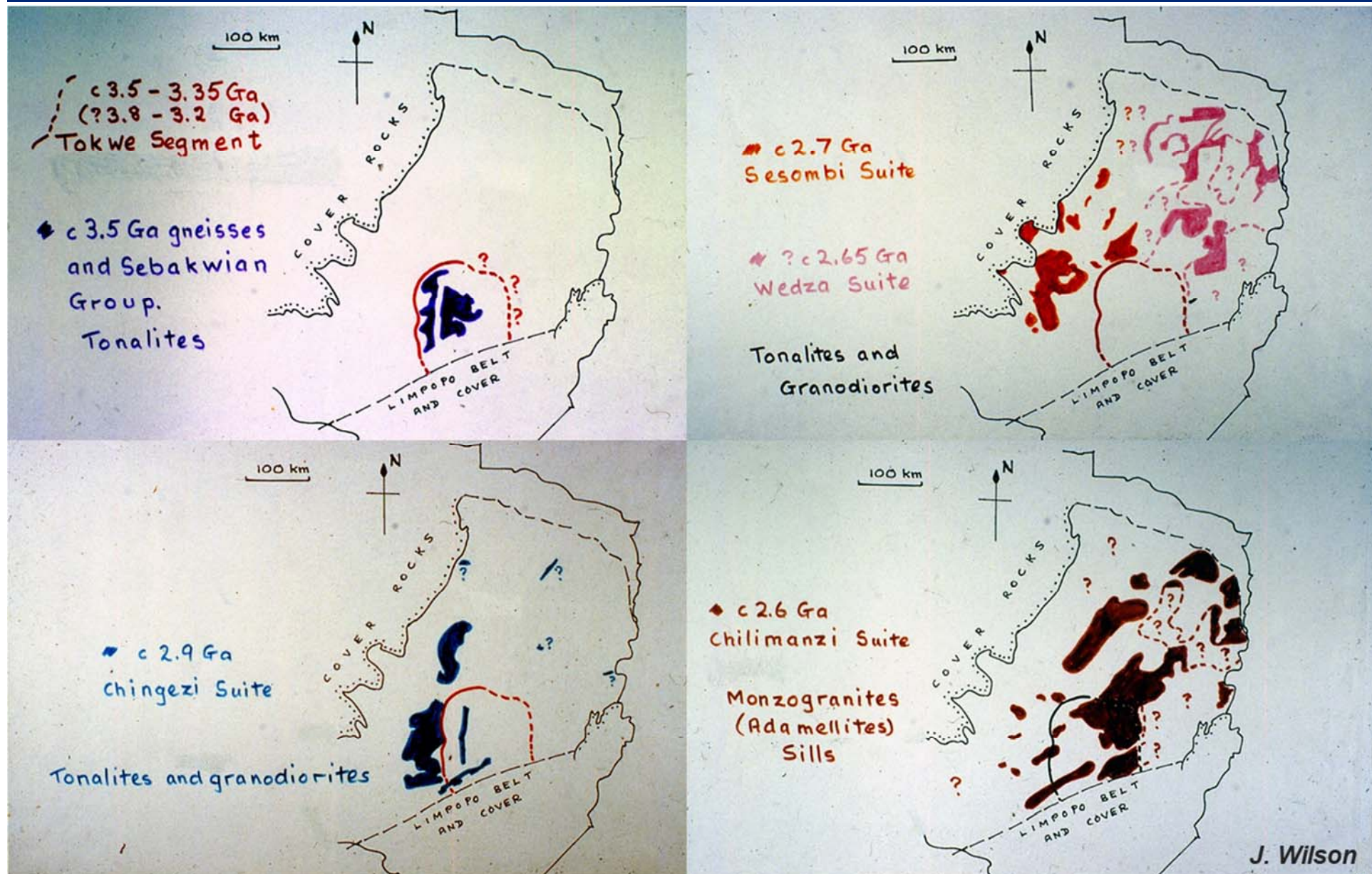
ARCHEAN GEOLOGY OF ZIMBABWE

Wilson et al. 1995



ARCHEAN GEOLOGY OF ZIMBABWE

Wilson et al. 1995

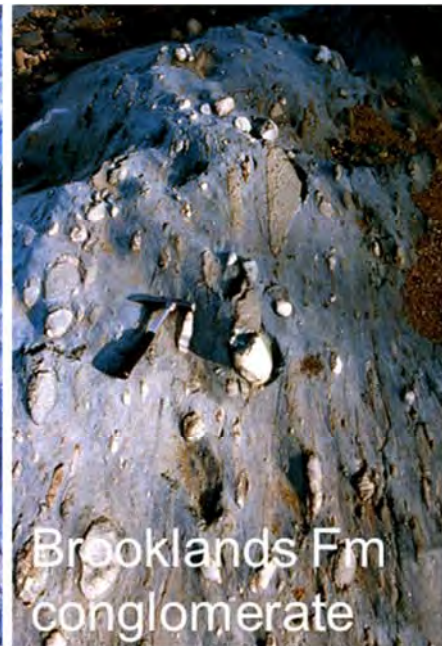


ARCHEAN GEOLOGY OF ZIMBABWE

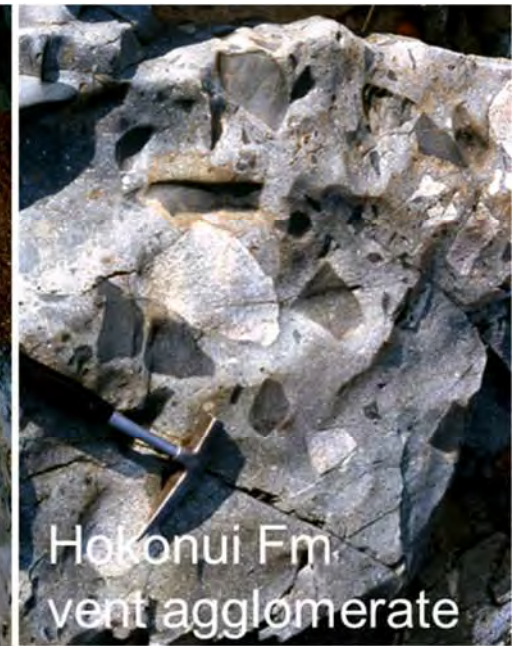
Sebakwian, Bulawayan and Shamvaian (southern Zimbabwe)



Sebakwian amphibolites



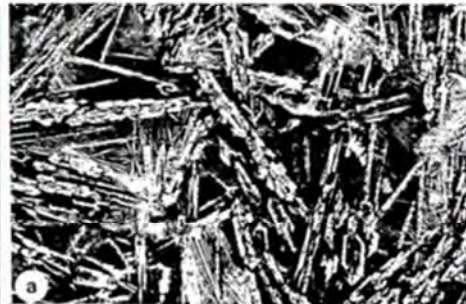
Brooklands Fm
conglomerate



Hokonui Fm
vent agglomerate



Manjeri Fm
unconformity



Reliance Fm
komatiites



Zeederbergs Fm
pillow basalts



Iron Mask Fm BIF



Lower Shamvaian
lapilli tuffs

Nisbet et al. 1987, Tony's Flow

ARCHEAN GEOLOGY OF ZIMBABWE

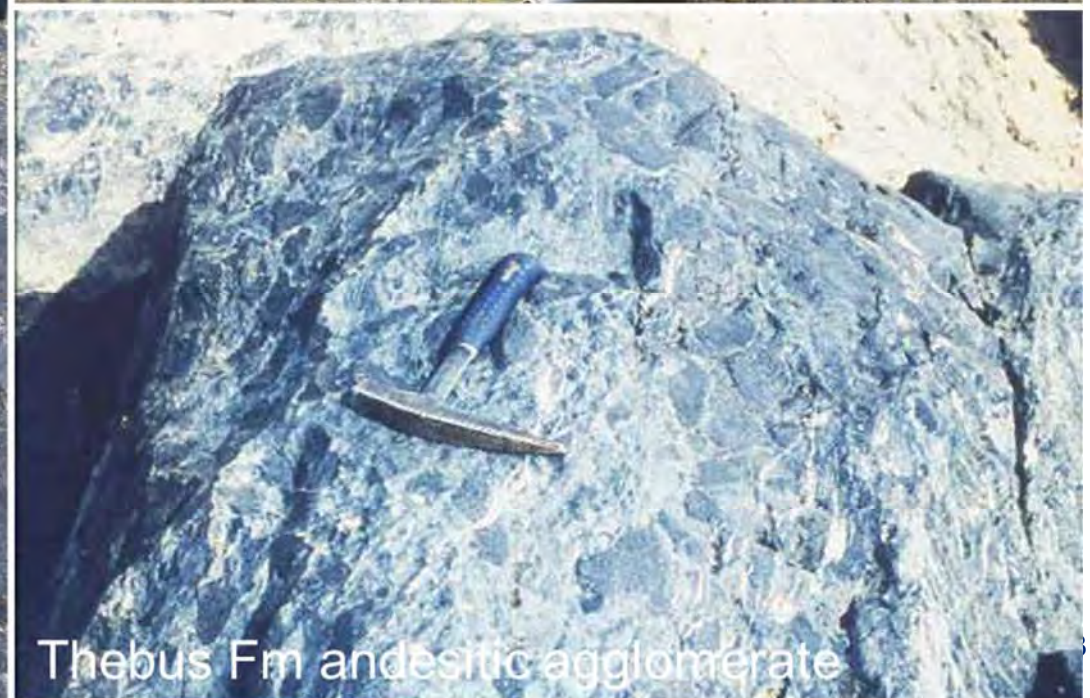
Bulawayan (northern Zimbabwe)



Mungari Fm pillow basalts



Maparu Fm porphyritic rhyodacites



Thebus Fm andesitic agglomerate

ARCHEAN GEOLOGY OF ZIMBABWE

Shamvaian



ARCHEAN GEOLOGY OF ZIMBABWE

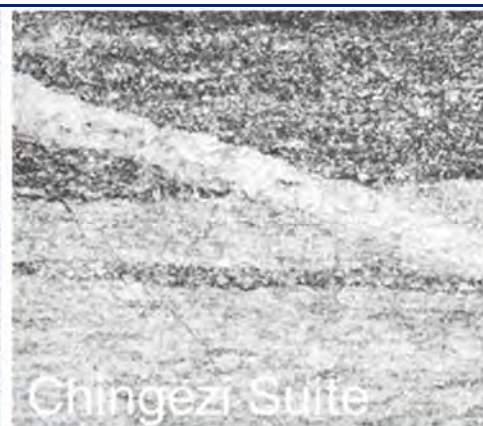
Basement Complex



Tokwe Gneiss



Tokwe Gneiss



Chingezi Suite



Wedza Suite



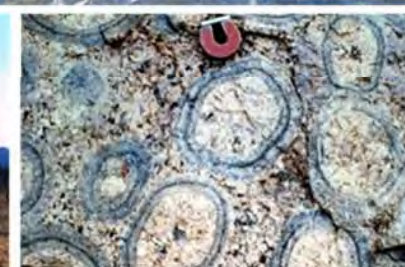
Chingezi Suite



Mwenje Dam granodiorite



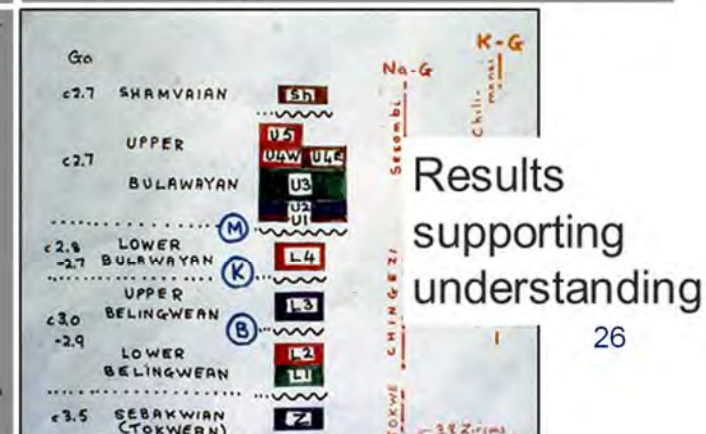
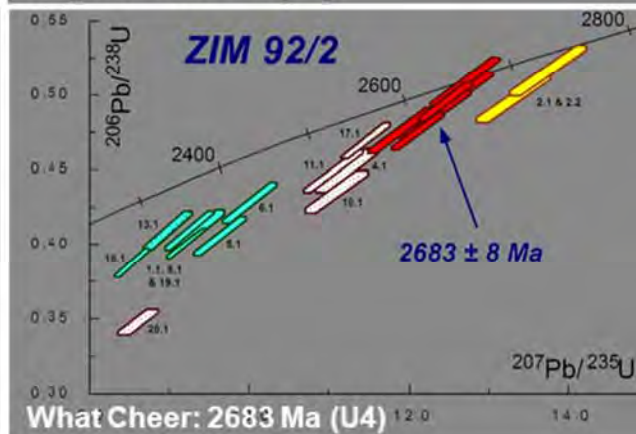
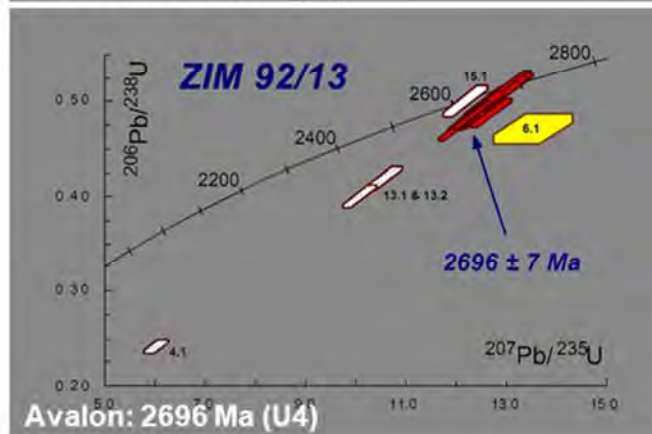
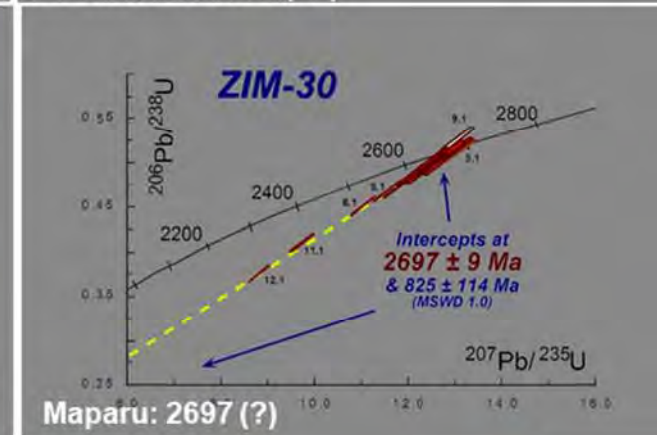
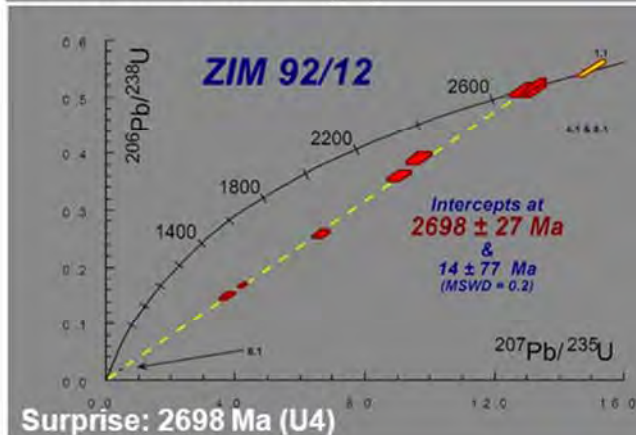
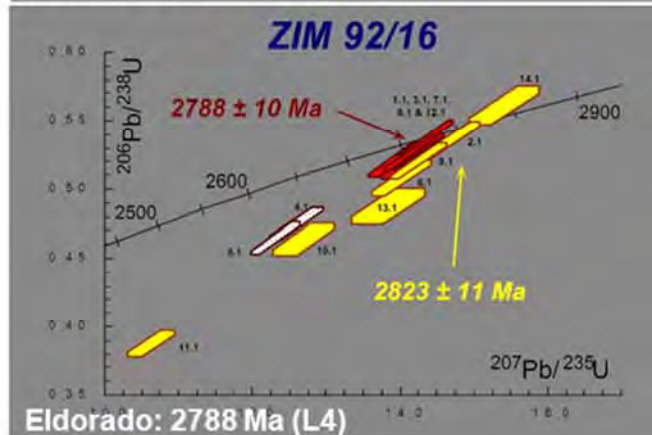
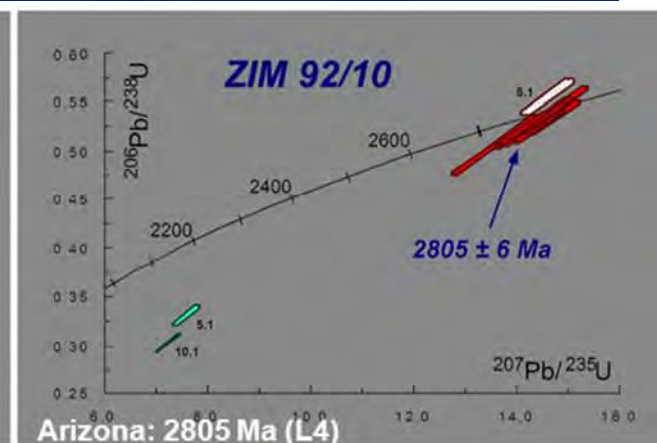
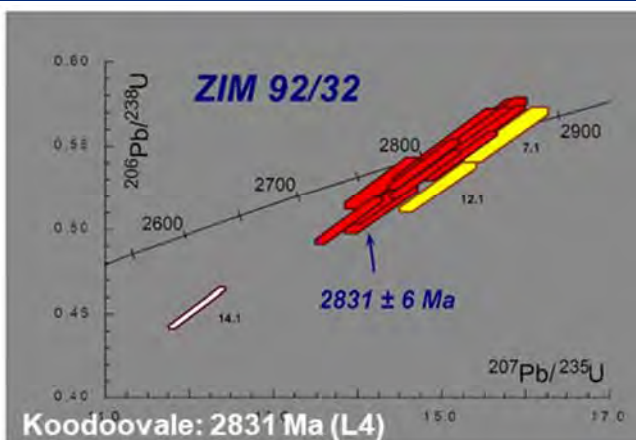
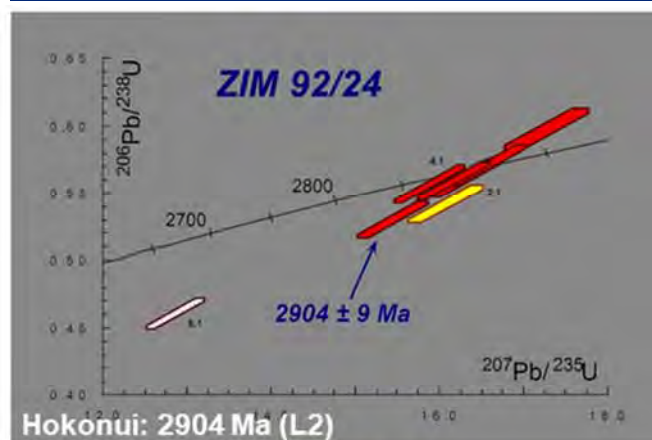
Chilimanzi Suite



Orbicular granites

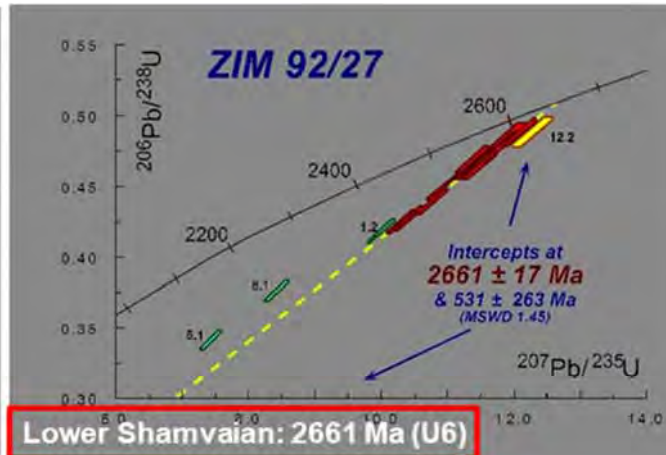
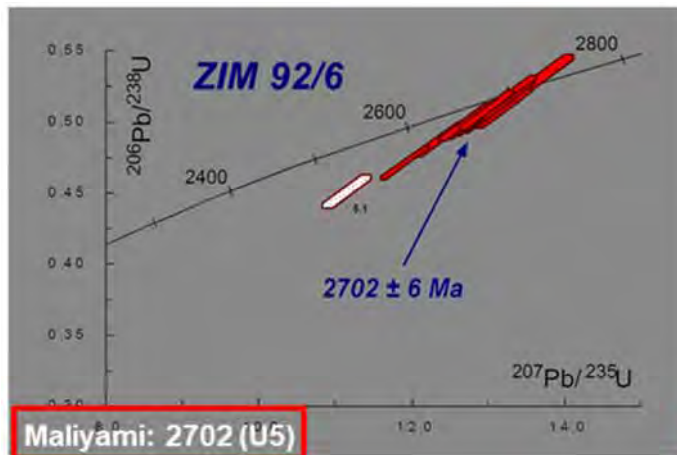
ARCHEAN GEOLOGY OF ZIMBABWE

Geochronology (Wilson et al. 1995; Nesbitt, unpublished data)

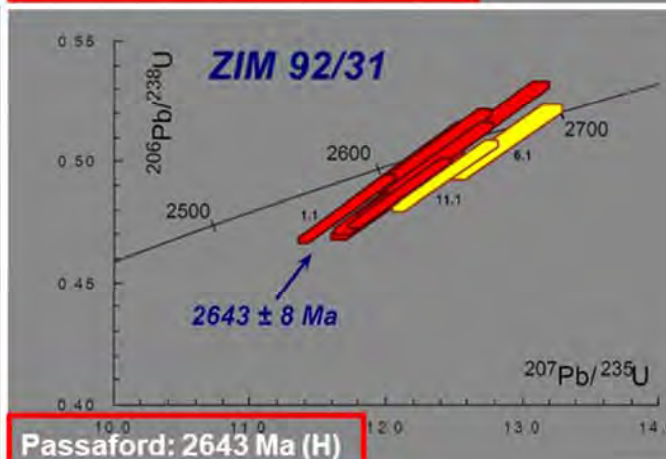
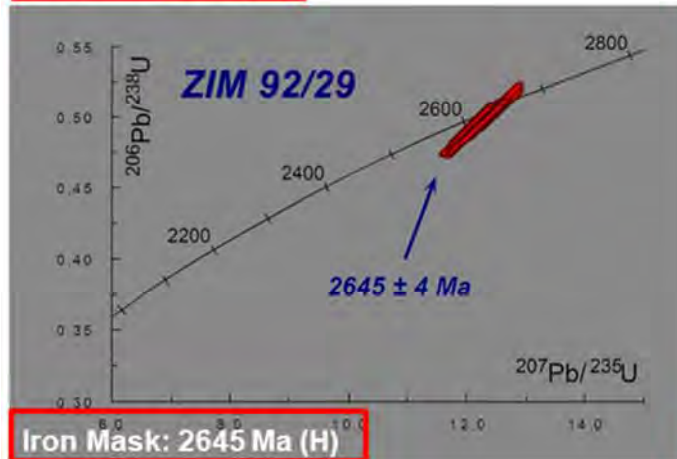


CURRENT UNDERSTANDING

Geochronology (Wilson et al. 1995; Nesbitt, unpublished data)



Results not supporting understanding



- Maliyami is the youngest formation (U5) in the Midlands belt
- Iron Mask and Passaford are the oldest and youngest formations in Harare belt
- Passaford Formation is intruded by the 2647 Ma Mazowe granodiorite
- Iron Mask Formation was dated by Jelsma et al. (1996) at 2714 Ma
- Shamvaian of the Masvingo Belt is older than Upper Bulawayan of Harare belt

CURRENT UNDERSTANDING

1995-present



Remnants of an Archean oceanic plateau, Belingwe greenstone belt, Zimbabwe

1992

T. M. Kusky

Department of Geosciences and Allied Geophysical Laboratories, University of Houston, Houston, Texas 77204-5503

W.S.F. Kidd

Department of Geological Sciences, State University of New York at Albany, 1400 Washington Avenue, Albany, New York 12222

Ensialic origin for the Ngezi Group, Belingwe greenstone belt, Zimbabwe

1993

Tom G. Blenkinsop Department of Geology, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe
Christopher M. Fedo Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

Michael J. Bickle Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, England
Kenneth A. Eriksson Department of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061

Anthony Martin 6 Autumn Close, Greendale, Harare, Zimbabwe
Euan G. Nisbet Department of Geology, Royal Holloway, University of London, Egham, Surrey TW20 0EX, England
James F. Wilson Department of Geology, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe

Neoarchaean tectonic evolution of the Zimbabwe Craton

HIELKE A. JELSMA¹ & PAUL H. G. M. DIRKS²

¹ CIGCES, Department of Geological Sciences, University of Cape Town, Rondebosch 7701, South Africa (e-mail: jelsma@cigces.uct.ac.za)

² School of Geosciences, University of the Witwatersrand, Private Bag 3, WITS 2050, South Africa

2002

Journal of the Geological Society, London, Vol. 160, 2003, pp. 83–97. Printed in Great Britain.

A tectonic origin for ironstone horizons in the Zimbabwe craton and their significance for greenstone belt geology

2003

A. HOFMANN¹, P. H. G. M. DIRKS¹, H. A. JELSMA² & N. MATURA³

Horizontal accretion and stabilization of the Archean Zimbabwe Craton

1998

Paul H. G. M. Dirks
Hielke A. Jelsma

Department of Geology, University of Zimbabwe, MP167, Harare, Zimbabwe

TECTONICS, VOL. 19, NO. 1, PAGES 135-152 FEBRUARY 2000

Tectonic evolution of a greenstone sequence in northern Zimbabwe: sequential early stacking and pluton diapirism

Hielke A. Jelsma and Paul H. G. M. Dirks

Department of Geology, University of Zimbabwe, Harare

2000

Precambrian Ophiolites and Related Rocks

Edited by Timothy M. Kusky

Developments in Precambrian Geology, Vol. 13 (K.C. Condie, Series Editor)

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Chapter 15

2004

THE BELINGWE GREENSTONE BELT: ENSIALIC OR OCEANIC?

AXEL HOFMANN^a AND TIM KUSKY^b

Journal of the Geological Society, London, Vol. 168, 2011, pp. 941–952. doi: 10.1144/0016-76492010-156.

The growth of the Zimbabwe Craton during the late Archean: an ion microprobe U–Pb zircon study

HUGH R. ROLLINSON^{1*} & MARTIN WHITEHOUSE²

2011 28

Ongoing debate

- Geodynamic setting: rift/arc/back-arc
- Nature of contacts: stratigraphic/tectonic
- Style of deformation: thrusting/doming

CURRENT UNDERSTANDING

1995-present



Contrib Mineral Petrol (1996) 124:55–70

© Springer-Verlag 1996

Hielke A. Jelsma · Michael L. Vinyu
Peter J. Valbracht · Gareth R. Davies
Jan R. Wijbrans · Ed A.T. Verdurmen

1993/1996

**Constraints on Archaean crustal evolution of the Zimbabwe craton:
a U-Pb zircon, Sm-Nd and Pb-Pb whole-rock isotope study**



U-Pb zircon evidence for an extensive early Archaean craton in
Zimbabwe: A reassessment of the timing of craton formation,
stabilization, and growth

1999

Matthew S. A. Horstwood^a Department of Geology, Southampton Oceanography Centre, Southampton SO14 3ZH, UK
Robert W. Nesbitt
Stephen R. Noble NERC Isotope Geoscience Laboratory, Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG, UK
James F. Wilson Department of Geology, University of Zimbabwe, P.O. Box MP167, Harare, Zimbabwe



Pergamon

PII: S0899-5362(00)00025-2

**U-Pb zircon ages from a craton-margin Archaean orogenic
belt in northern Zimbabwe**

M.L. VINYU^{1,1}, R.E. HANSON^{2,*}, M.W. MARTIN³, S.A. BOWRING³,
H.A. JELSMA¹ and P.H.G.M. DIRKS¹

2001[†]

**Zircon geochronology and partial structural
re-interpretation of the late Archaean Mashaba Igneous Complex,
south-central Zimbabwe**

M.D. Prendergast

Guesachan, Shielhill Road, Kirriemuir, Angus DD8 4PA, Scotland,
United Kingdom
e-mail: marprend@hotmail.com

M.T.D. Wingate

Geological Survey of Western Australia, 100 Plain St., East Perth, WA 6004, Australia,
and Tectonics Special Research Centre, School of Earth and Geographical Sciences,
University of Western Australia, WA 6004, Australia
e-mail: michael.wingate@doir.wa.gov.au

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2007

Journal of the Geological Society, London, Vol. 168, 2011, pp. 941–952, doi: 10.1144/0016-76492010-156.

**The growth of the Zimbabwe Craton during the late Archaean: an ion microprobe
U–Pb zircon study**

2011

HUGH R. ROLLINSON^{1*} & MARTIN WHITEHOUSE²

Precambrian Research 229 (2011) 105–174

Zircon geochronology of late Archean komatiitic sills and their felsic country
rocks, south-central Zimbabwe: A revised age for the Reliance komatiitic
event and its implications

M.D. Prendergast^{a,*}, M.T.D. Wingate^{b,c}

^a Guesachan, Shielhill Road, Kirriemuir, Angus DD8 4PA, Scotland, UK

^b Geological Survey of Western Australia, 100 Plain St., WA 6004, Australia

^c School of Earth and Environment, The University of Western Australia, WA 6009, Australia

2013

**Zircon U-Pb Geochronology of the Zimbabwean Craton:
Untangling the Stratigraphy of Greenstone Belts.**



Bob Nesbitt

Mark Fanning

Jim Wilson

Hielke Jelsma

Matt Horstwood

Southampton Oceanography Centre,

Australian National University

University of Zimbabwe

University of Zimbabwe

NIGL, BGS, UK

2000

CURRENT UNDERSTANDING

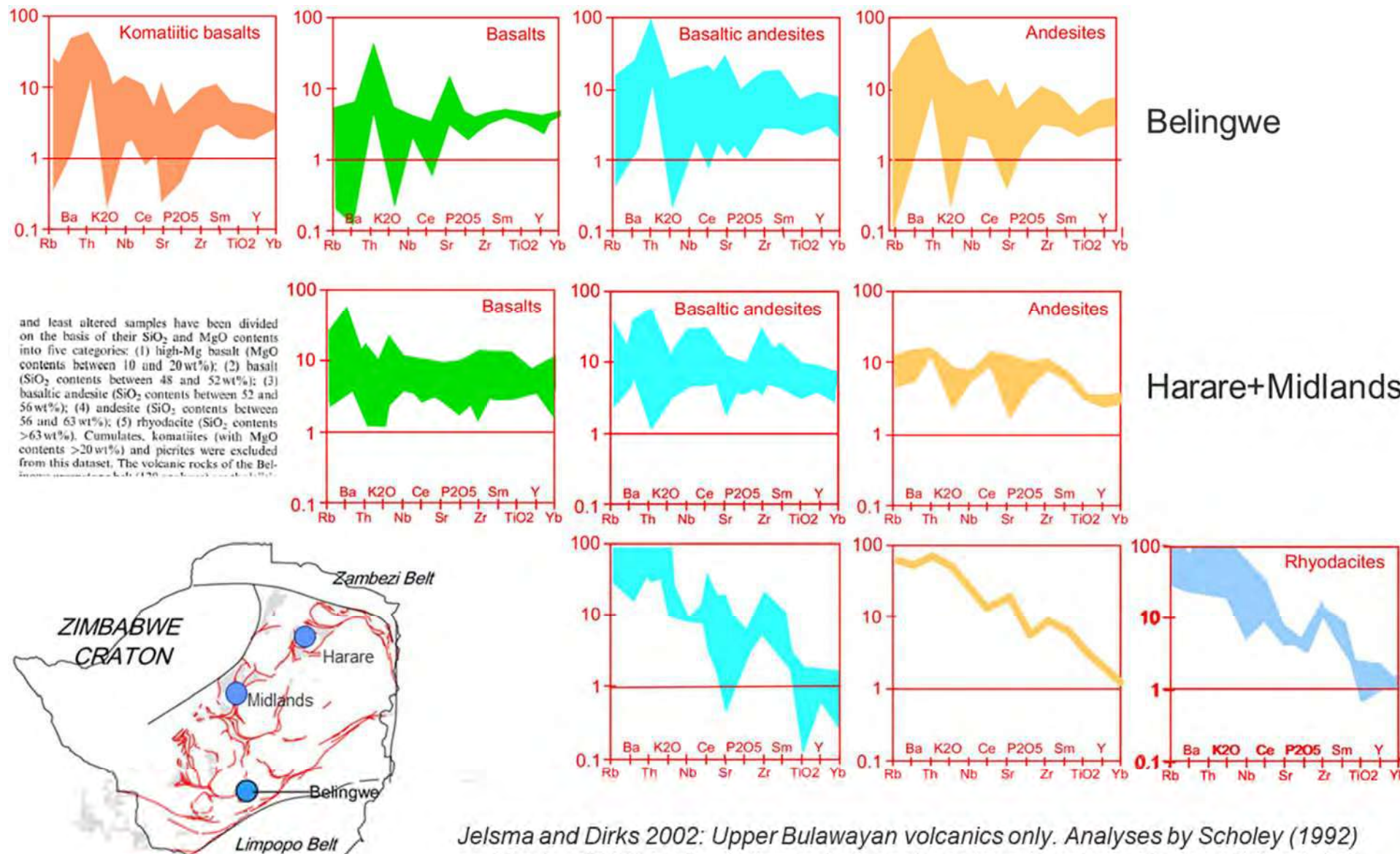


Macgregor 1947, 1951	Stagman 1978	Wilson 1979	Foster et al. 1986	Wilson et al. 1995	Informal	Geochronology	Int
	Great Dyke	Great Dyke	Great Dyke	Great Dyke		Great Dyke: 2574 ± 2 Ma East Dyke: 2574 ± 2 Ma Umvimeela (West) Dyke: 2577 ± 2 Ma	
Upper Series Shamvaian System clastic deposits	Shamvaian Group	Shamvaian Group	Shamvaian Group	Shamvaian Supergroup	Upper Shamvaian Group	Shamvaian Supergroup	Chilimanzi Suite: 2620 Ma Mudzi-Pfungwe Suite: 2622 Ma Razi Suite: 2627 Ma Glendale tonalite: 2618 Ma
				Lower Shamvaian Group	H H marker ? U6		Passaford Fm: 2643 Ma (2700 Ma?) Lake Kyle vent: 2661 Ma Porphyries: 2677-2666 Ma
Lower Series Bulawayan System mafic-felsic	Upper Bulawayan	Upper Greenstones	(Maliyami)	Upper Greenstones	Calcaline	U5	Maliyami Fm: 2702 Ma
		Cheshire		Bimodal Mixed		U4W/U4E	What Cheer Fm: 2683 Ma Avalon Fm: 2696 Ma Maparu Fm: 2697 Ma
		Zeederbergs		Basaltic		U3	Surprise Fm: 2698 Ma Zeederbergs Fm: 2698 Ma
		Reliance		Komatiitic		U2	Mashaba-Chibi dykes: 2700 Ma Wedza gneiss: 2704 Ma
		Manjeri		Sedimentary		U1	Reliance Fm: 2745 Ma Sills: 2740-2733 Ma (Phurombuzi, Shangani)
		Manjeri marker		Manjeri marker		M marker M marker	Iron Mask Formation: 2715 Ma Manjeri Fm: >2745 Ma
		Koodoovale				L4	Koodoovale Fm: 2803-2788 Ma Arizona Fm: 2805 Ma Eldorado Fm: 2799-2788 Ma
		K marker					
		Bend		Lower Greenstones		L3	Brooklands Fm Buchwa quartzite
		B marker				B marker B marker	
		Hokonui				L2	Mafic Fm: 2880-2870 Ma Hokonui Fm: 2904 Ma
						L1	Manica felsic volcanics: 2990 Ma
Magnesian System Sebakwian System	Sebakwian Group	Sebakwian Group	Sebakwian Group	Sebakwian Group			> 3375 Ma
							Mushandike Granite: 3375 Ma Shabani Gneiss: 3475 Ma Tokwe Gneiss: 3554 Ma Sebakwe River Gneiss: 3565 Ma

Key papers: Wilson et al. (1995); Jelsma et al. (1996); Horstwood et al. (1999); Nesbitt et al. (2000); Armstrong and Wilson (2000); Wingate (2000); Prendergast and Wingate (2007, 2013); Jelsma and Barton (unpublished). Pre-SHRIMP/TIMS: Hickman, Wilson, Moorbath, Hawkesworth, Hamilton, and Taylor.

CURRENT UNDERSTANDING

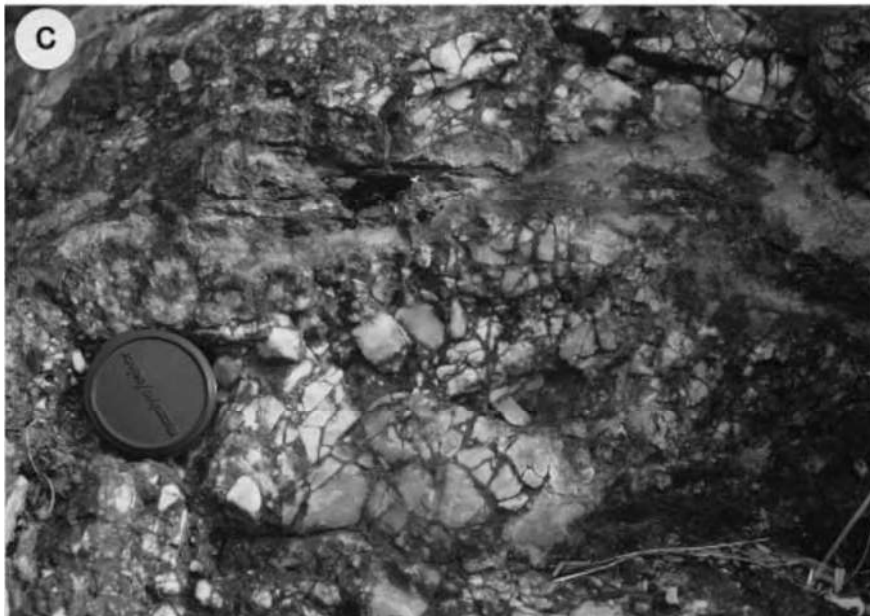
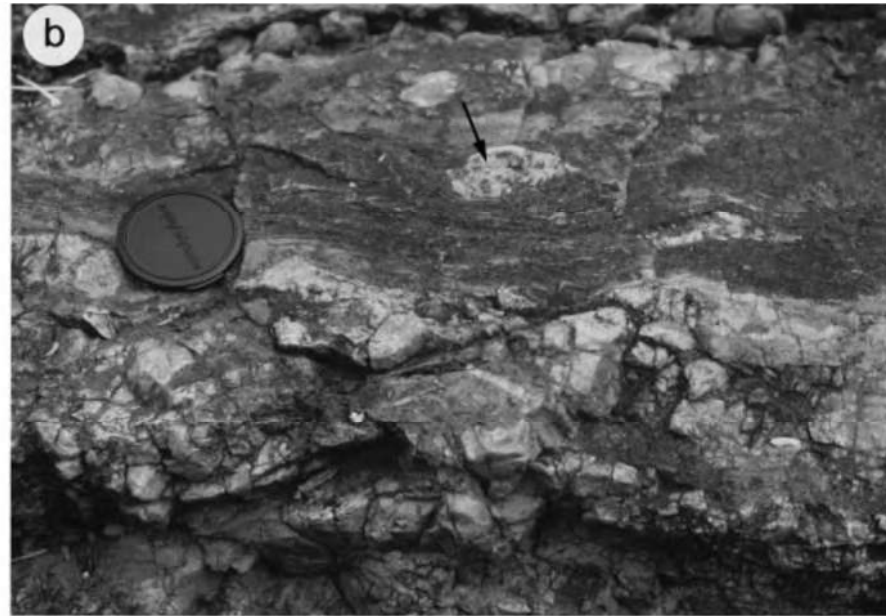
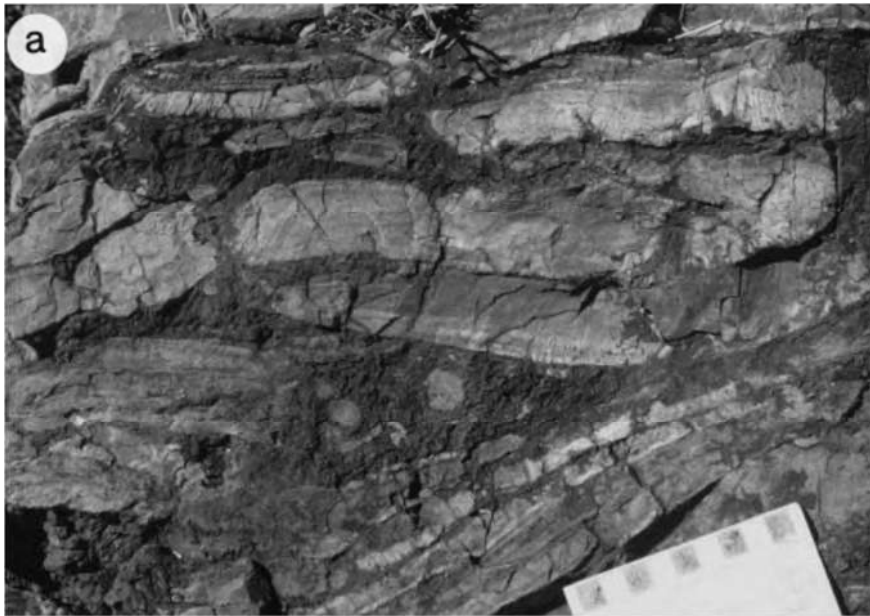
Differing volcanic geochemistry: Belingwe belt versus Harare and Midlands belts



Jelsma and Dirks 2002: Upper Bulawayan volcanics only. Analyses by Scholey (1992) and Brake (1996) for the Belingwe belt, analyses from Horstwood for the Midlands belt and analyses from Tomschi (1987) and Jelsma (1993) for the Harare belt

CURRENT UNDERSTANDING

Many contacts are complex: Manjeri Formation (upper part – Hofmann et al. 2001)



CURRENT UNDERSTANDING

Structural complexity, Midlands greenstone belt – leanings from Campbell and Pitfield

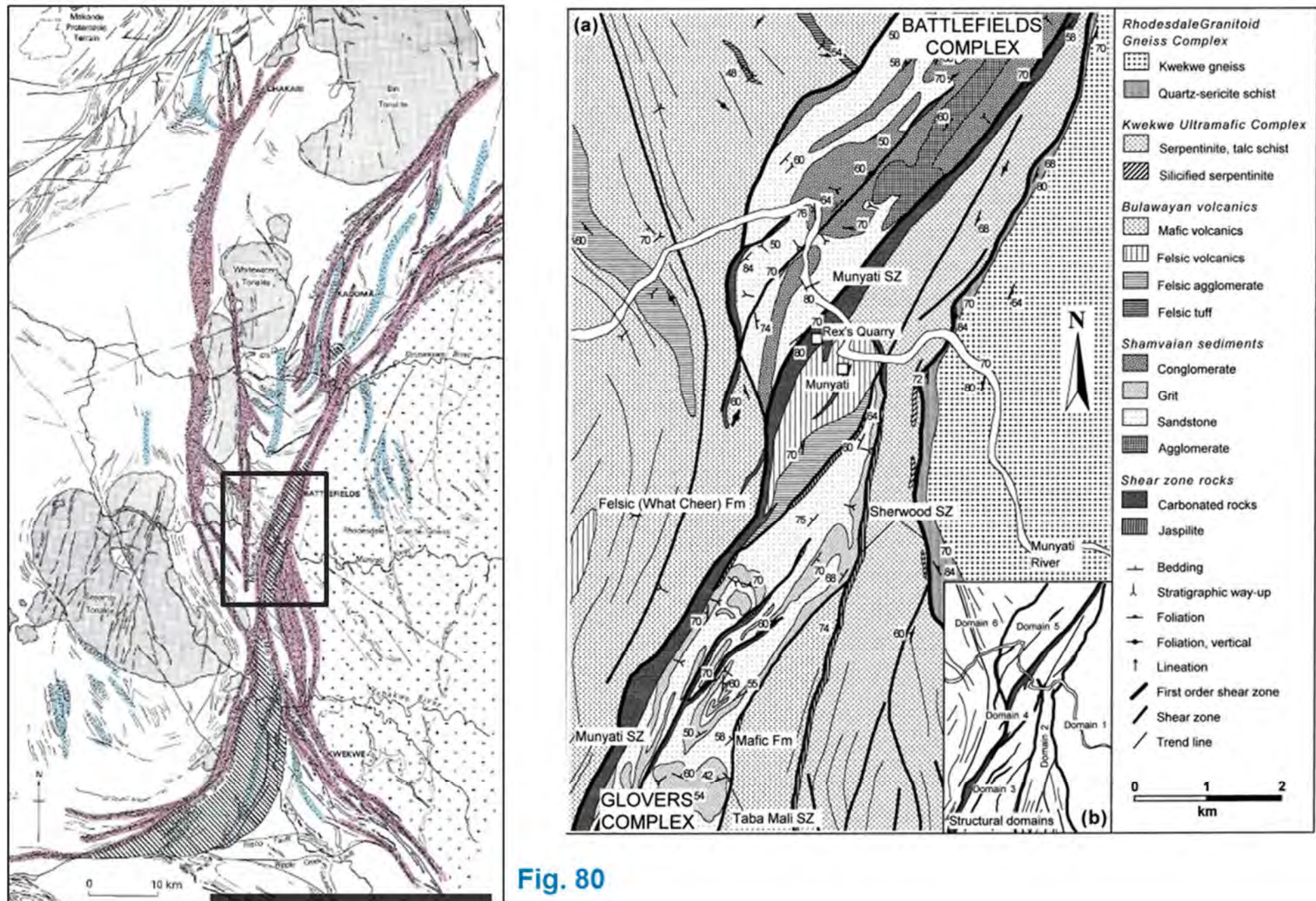
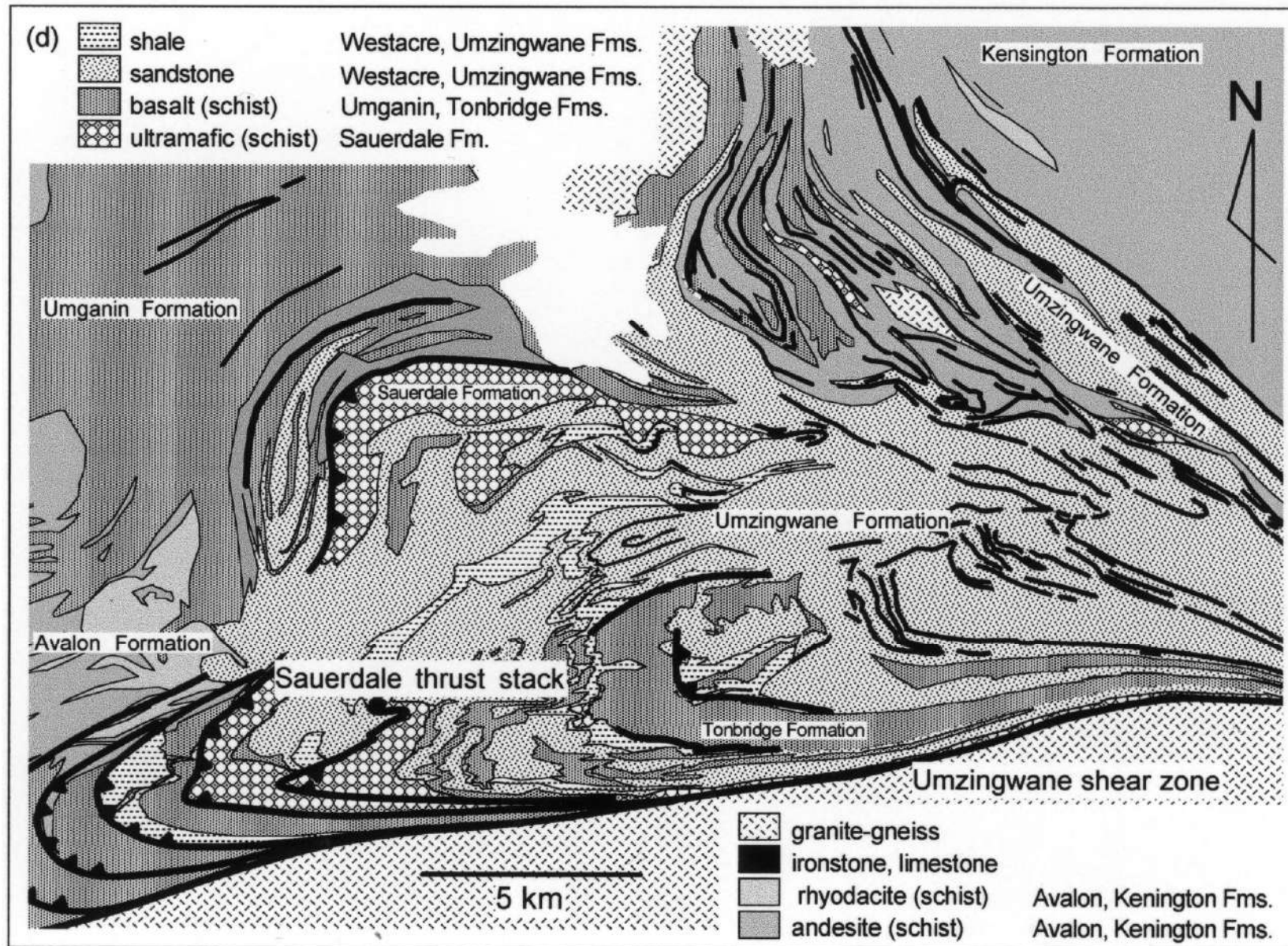


Fig. 80

CURRENT UNDERSTANDING

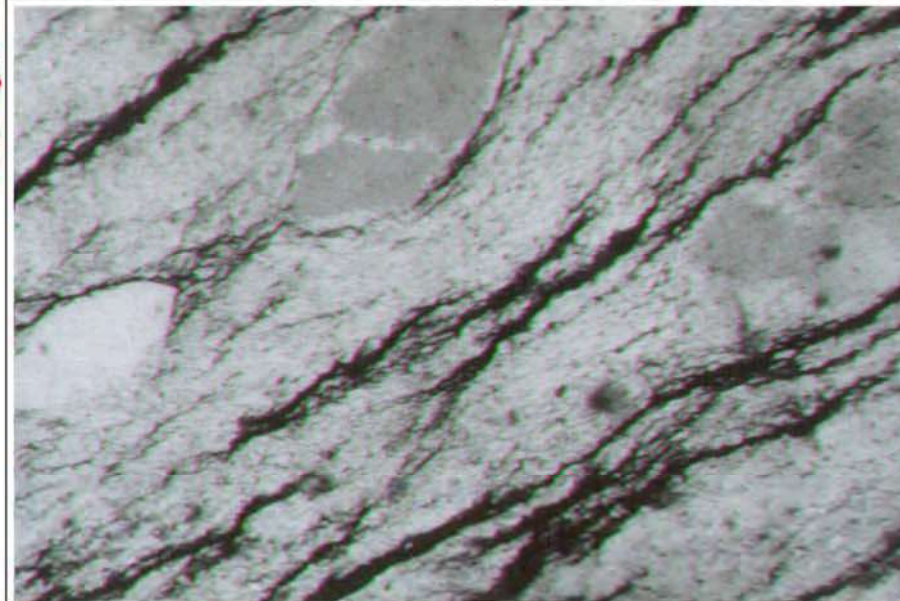
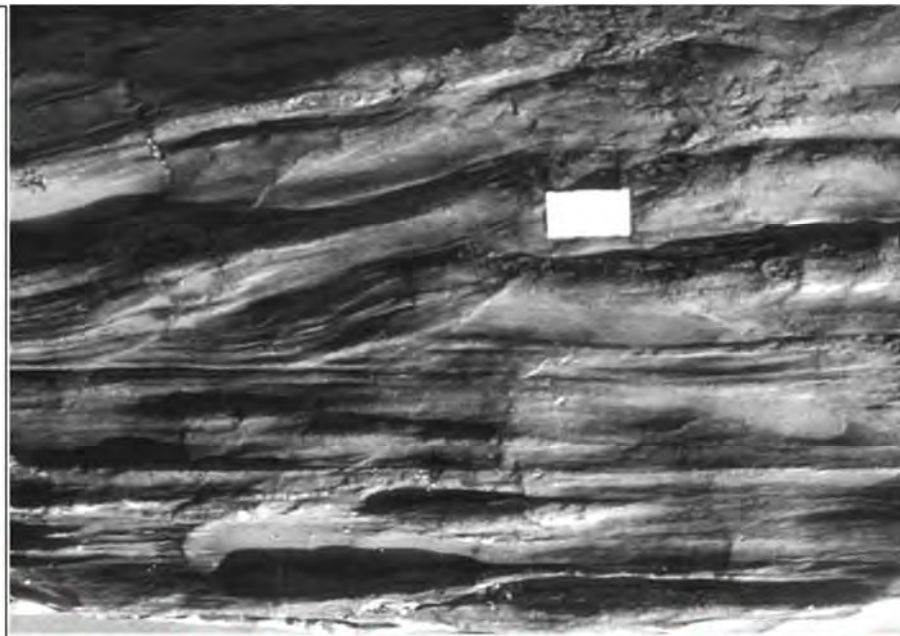
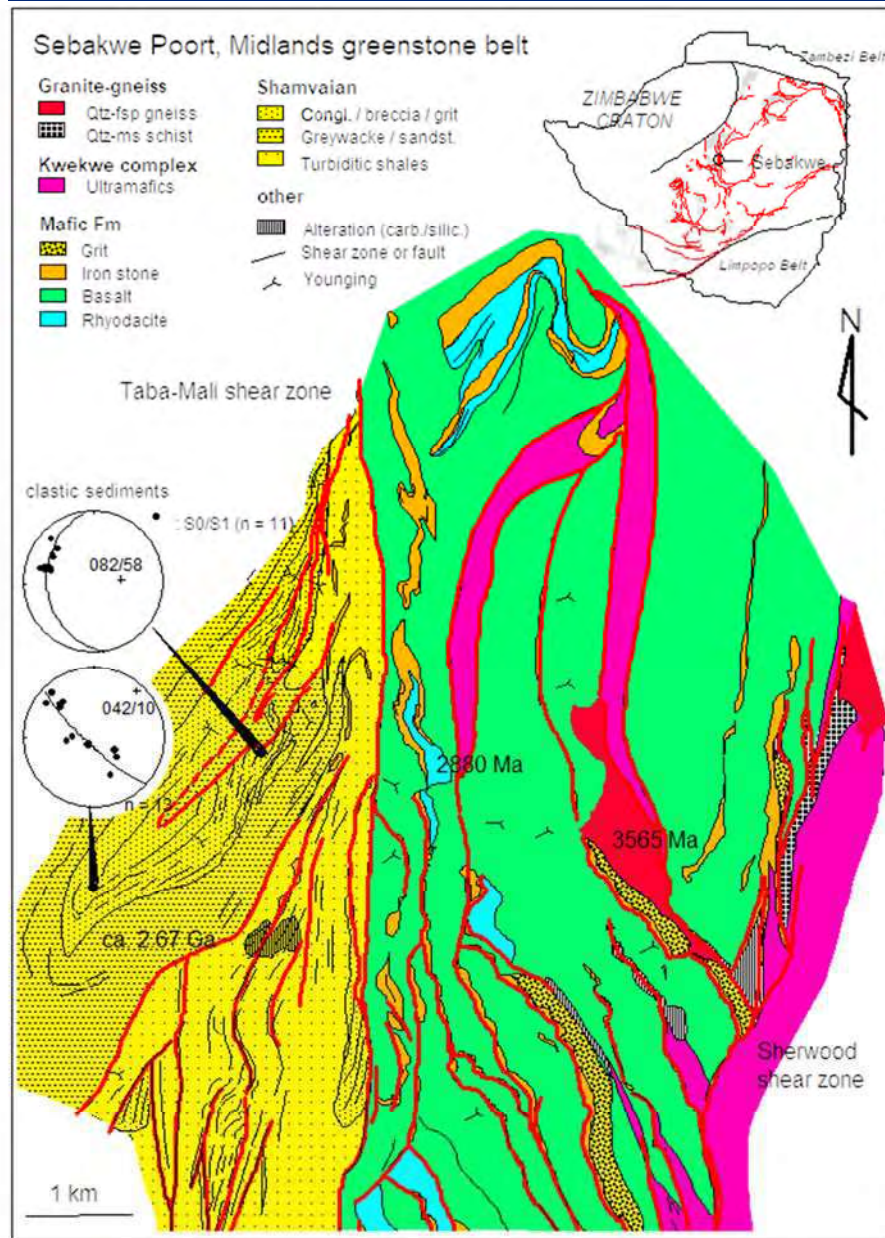
Structural complexity, Bulawayo greenstone belt



Jelsma and Dirks 2002: recognition of thrust stacks in Bulletin 93

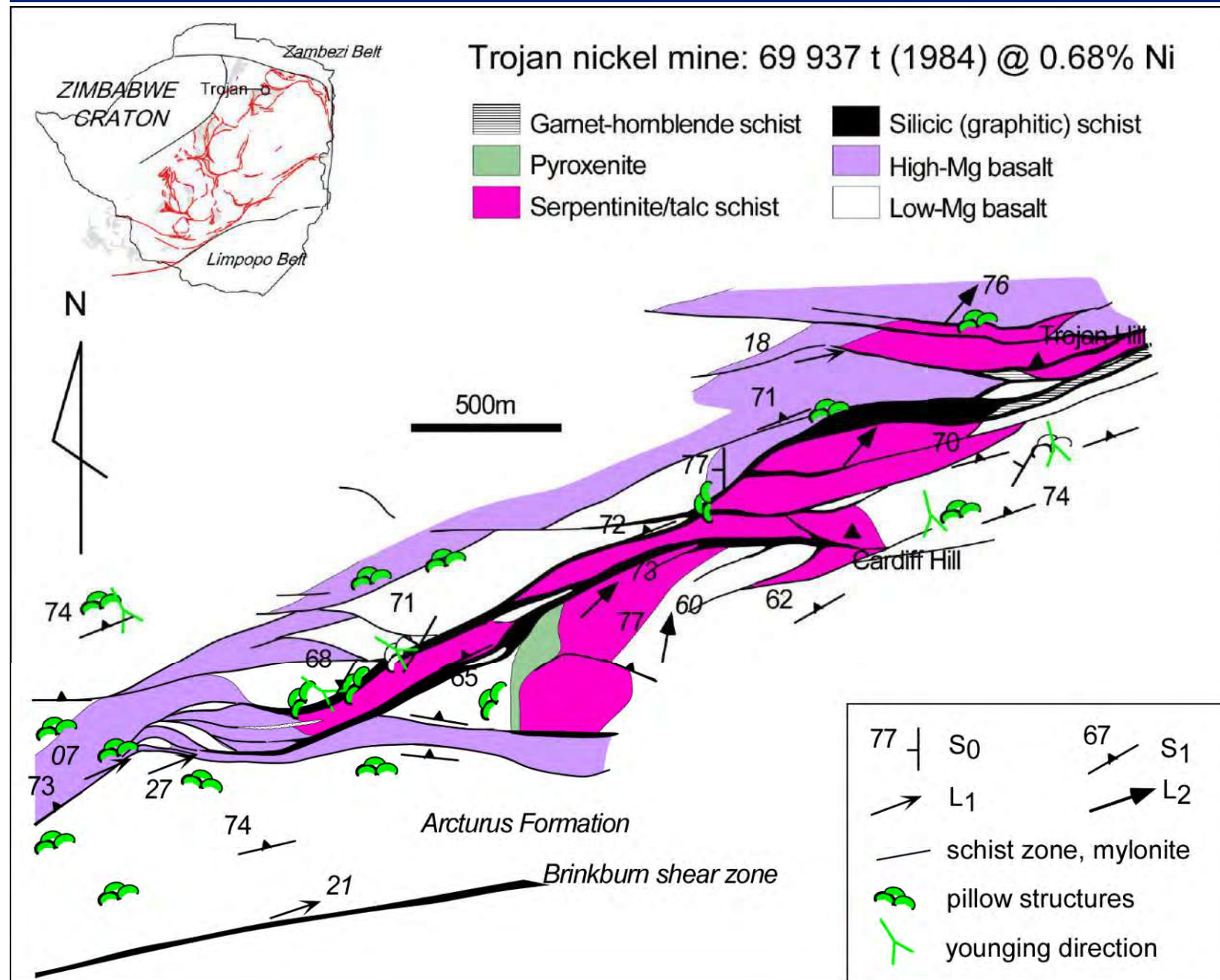
CURRENT UNDERSTANDING

Structural complexity, Midlands greenstone belt



CURRENT UNDERSTANDING

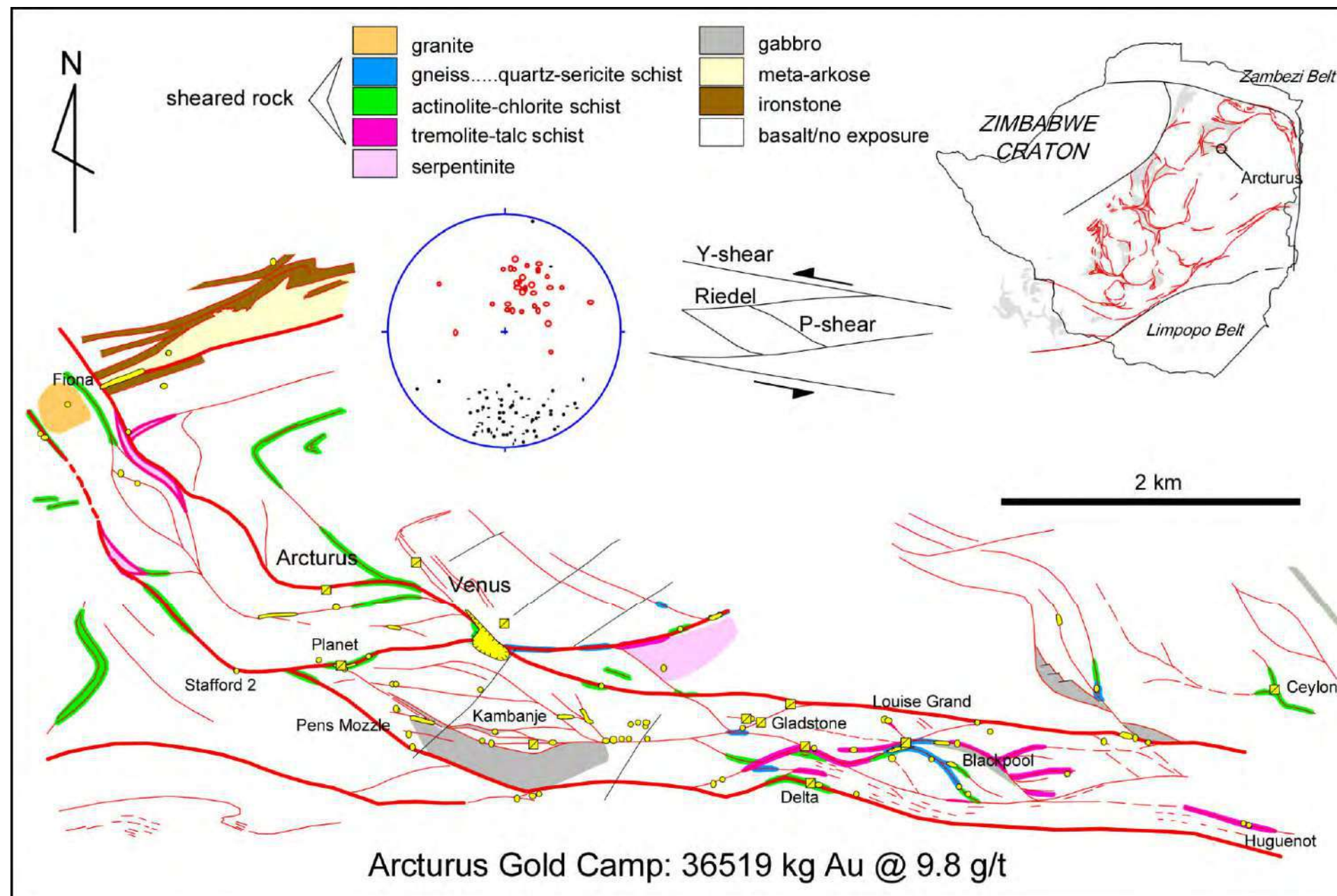
Structural complexity, Bindura greenstone belt



Jelsma and Dirks 2002

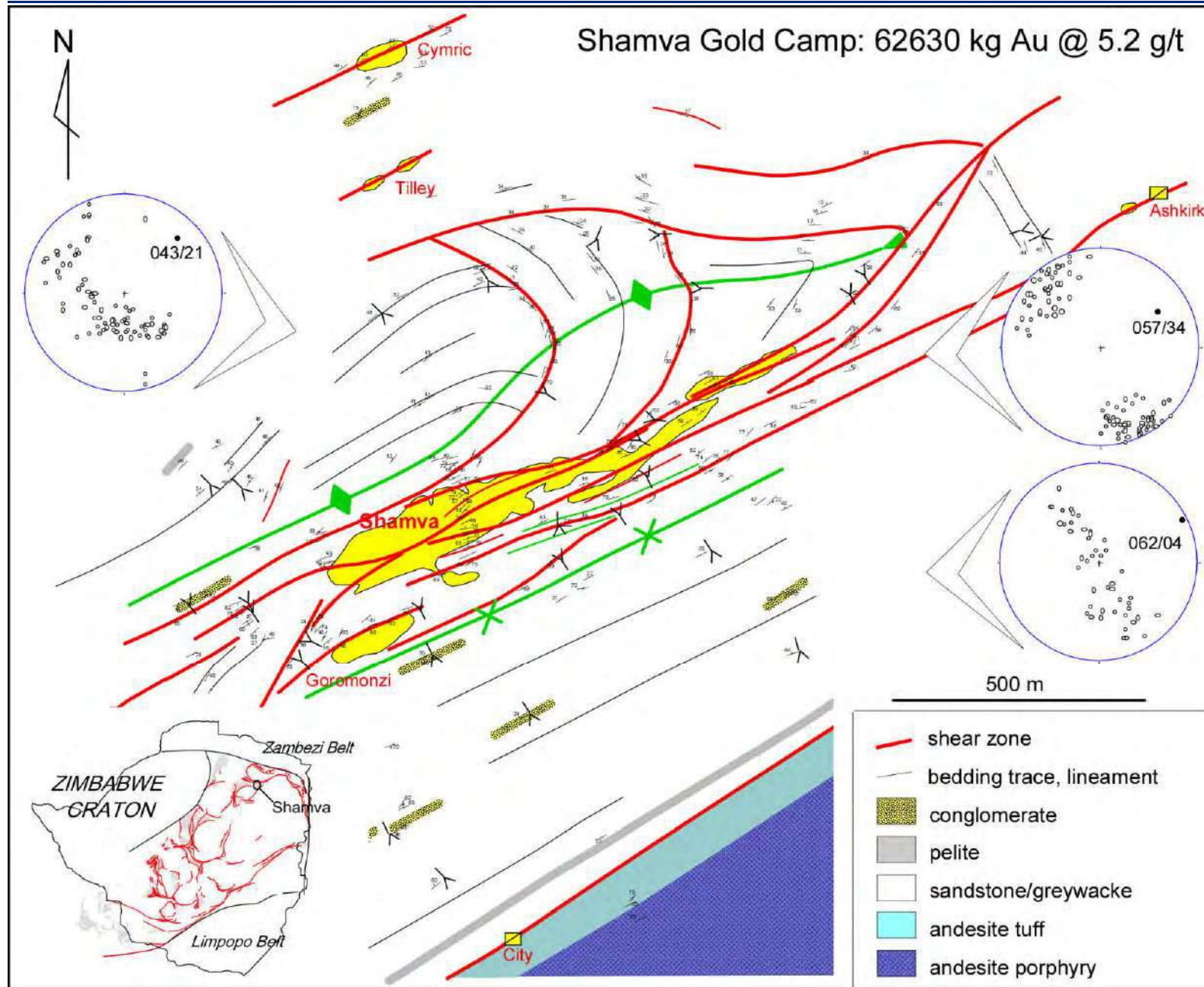
CURRENT UNDERSTANDING

Structural complexity, Harare greenstone belt



CURRENT UNDERSTANDING

Structural complexity, Shamva greenstone belt



UNTANGLING THE STRATIGRAPHY

Work presented by Bob Nesbitt in Manchester in 2000



Zircon U-Pb Geochronology of the Zimbabwean Craton: Untangling the Stratigraphy of Greenstone Belts.

Bob Nesbitt

Southampton Oceanography Centre,

Mark Fanning

Australian National University

Jim Wilson

University of Zimbabwe

Hielke Jelsma

University of Zimbabwe

Matt Horstwood

NIGL, BGS, UK



Southampton
Oceanography
Centre



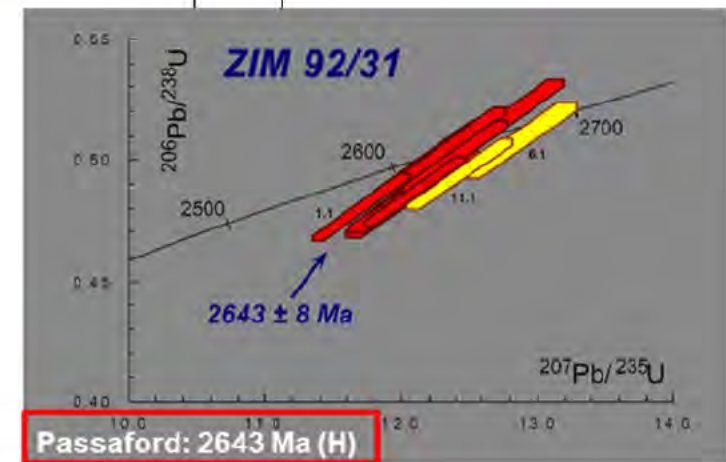
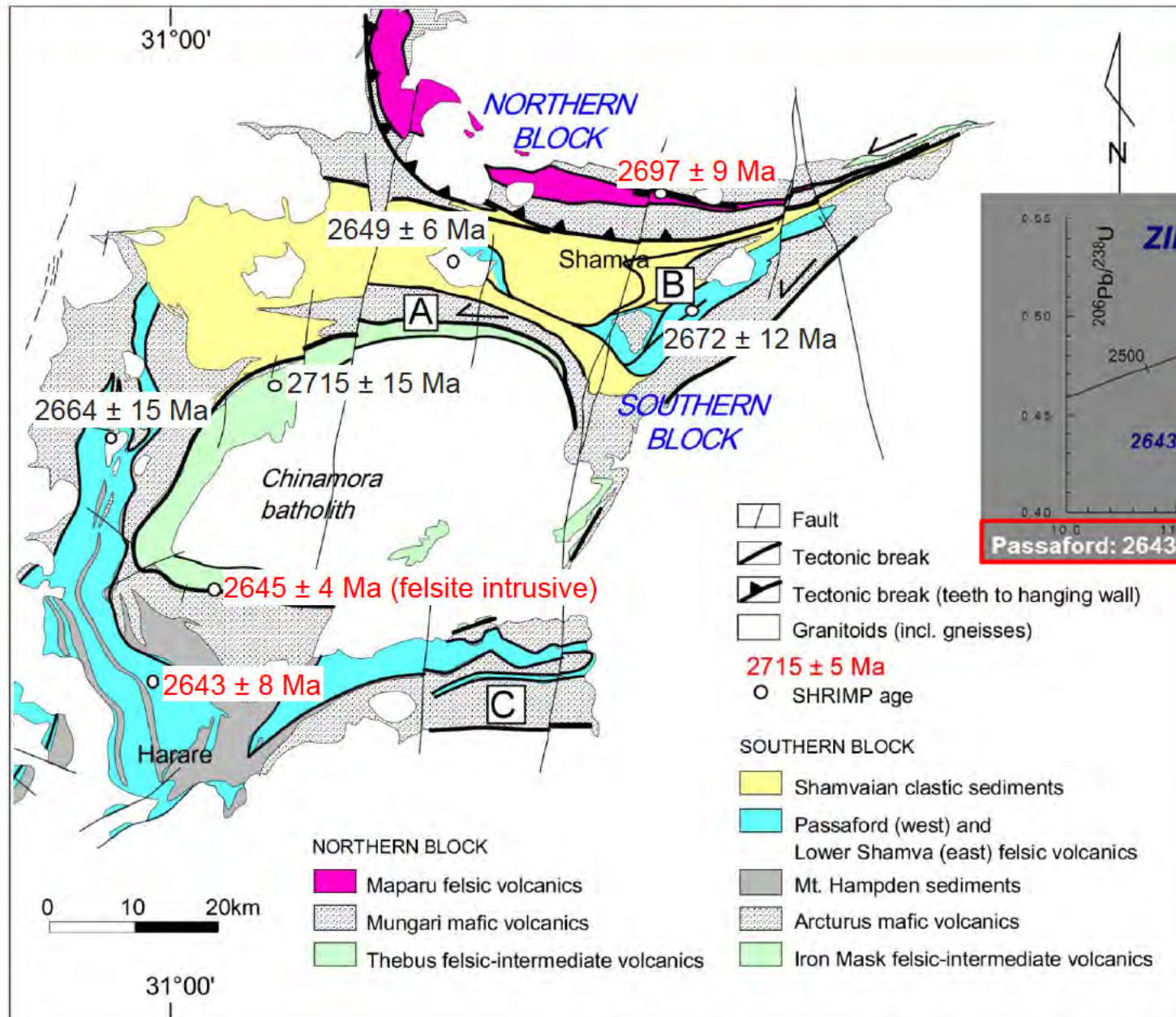
Isotope
Geochemistry
Unit



University
of Southampton

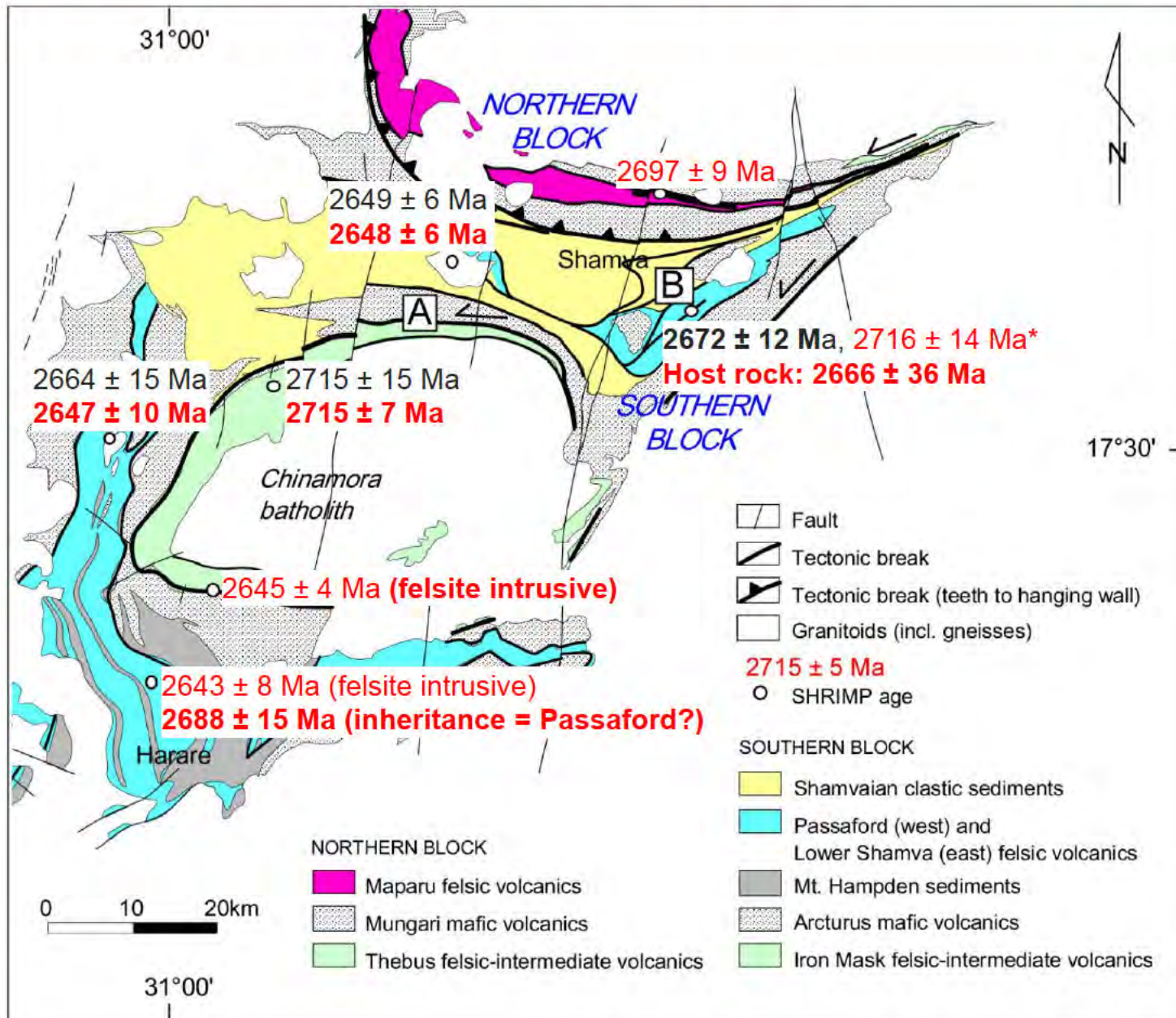
UNTANGLING THE STRATIGRAPHY

Reinterpretation of TIMS and SHRIMP zircon ages, Harare-Shamva greenstone belt



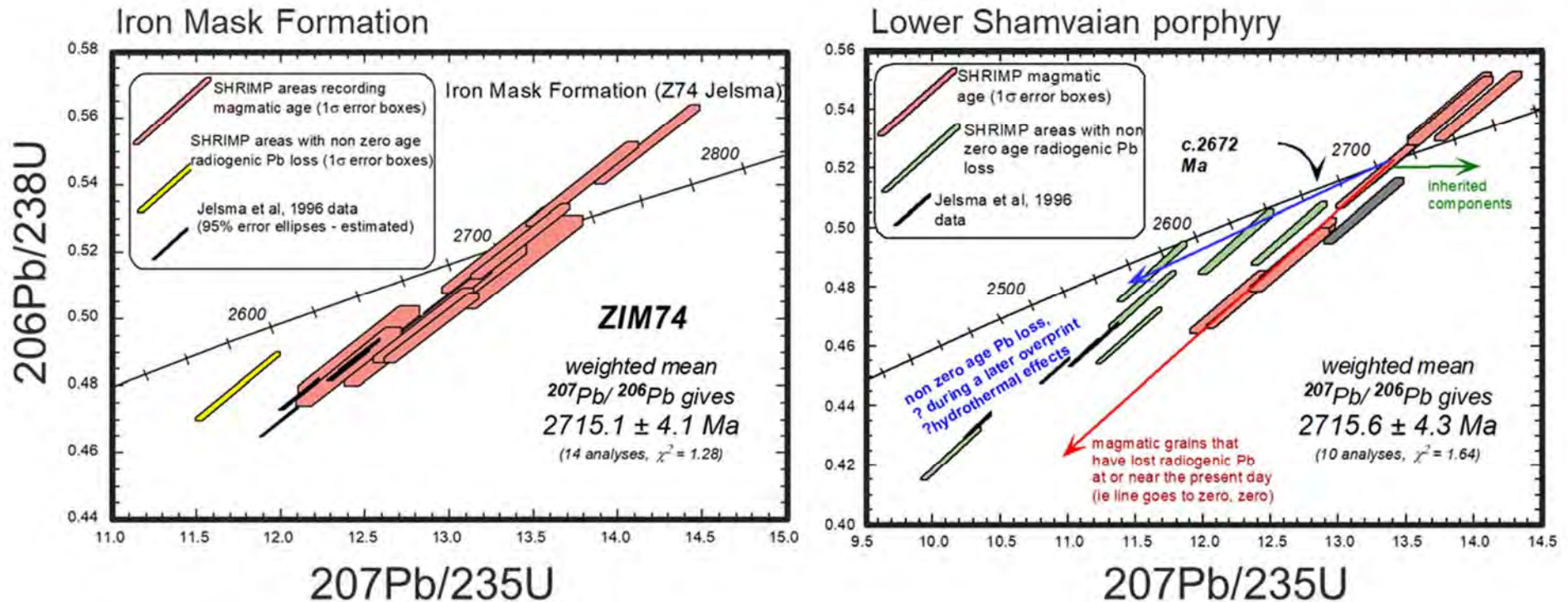
UNTANGLING THE STRATIGRAPHY

Reinterpretation of TIMS and SHRIMP zircon ages, Harare-Shamva greenstone belt



UNTANGLING THE STRATIGRAPHY

Reinterpretation of TIMS and SHRIMP zircon ages, Harare-Shamva greenstone belt



ZIM 74, Iron Mask: Multigrain TIMS gives $2715 \pm 15 \text{ Ma}$ and SHRIMP gives $2715 \pm 7 \text{ Ma}$

ZIM29, Lower Shamvaian: Multigrain TIMS gives $2672 \pm 15 \text{ Ma}$ and SHRIMP gives $2716 \pm 14 \text{ Ma}$

ZIM97-01, Lower Shamvaian: Host rock to Black Cat porphyry dated at $2666 \pm 30 \text{ Ma}$

Nesbitt et al.; 2000

UNTANGLING THE STRATIGRAPHY

Reinterpretation of TIMS and SHRIMP zircon ages, Harare-Shamva greenstone belt



Wilson-Nesbitt-Fanning phase:

- ZIM92/29, Banded felsic unit within or cutting Iron Mask Formation: SHRIMP 2645 ± 4 Ma
- ZIM92/30, Maparu Formation Waterlain tuff: SHRIMP 2697 ± 9 Ma
- ZIM 92/31, Felsic unit within **or cutting** Passaford Formation (Lomagundi Rd): SHRIMP 2643 ± 8 Ma

Jelsma-Nesbitt-Fanning phase: Fanning re-analysed some of the Jelsma samples

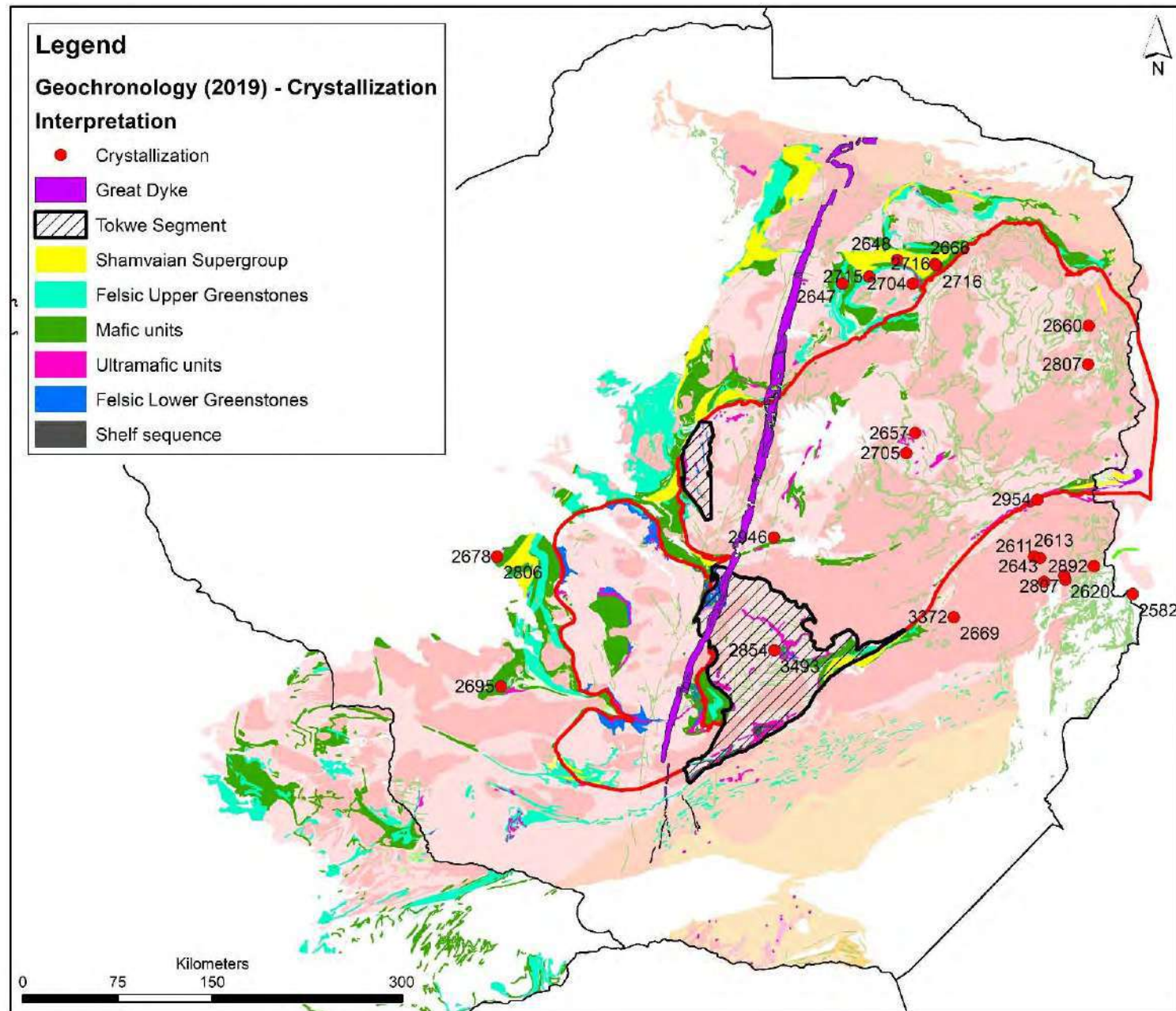
- ZIM74, Iron Mask Formation: TIMS 2715 ± 15 Ma and SHRIMP **2715 ± 7 Ma**
- ZIM29, Lower Shamvaian, Black Cat porphyry: TIMS 2672 ± 12 Ma, SHRIMP 2716 ± 14 Ma (complex)
- ZIM 97-01, Lower Shamvaian tuff and host to Black Cat. SHRIMP: **2666 ± 30 Ma**
- ZIM60, Wedza Suite gneiss, edge of Chinamora batholith: TIMS 2667 ± 4 Ma, SHRIMP **2704 ± 10 Ma**
- ZIM79, Mazowe granodiorite cuts Passaford Formation: TIMS 2664 ± 15 Ma, SHRIMP **2647 ± 4 Ma**
- ZIM80, Bindura granodiorite cuts Upper Shamvaian: TIMS 2649 ± 6 Ma, SHRIMP **2647 ± 6 Ma**

Discussion:

- Greenstone belt likely formed between 2715-2649 Ma.
- Vumba and Matsitama belts in Botswana fall in the same range: 2696-2647 Ma and 2710-2646 Ma.
- Wedza Suite may have been cogenetic with Iron Formation or Maparu Formation.
- Bimodal volcanism was followed by accretion and deposition of Shamvaian basin sediments.
- A major unconformity is found N of Shamva between Bulawayan basalts and Shamvaian sediments
- Juvenile gabbro-diorite-monzonite-tonalite-granodiorite intrusions are emplaced within greenstone belt at about 2645 Ma (Mazowe, Glendale, Bindura, Cadogan) and are host to major gold deposits.
- The Chilimanzi granites are emplaced afterwards at ~ 2620 Ma.

UNTANGLING THE STRATIGRAPHY

New geochronology

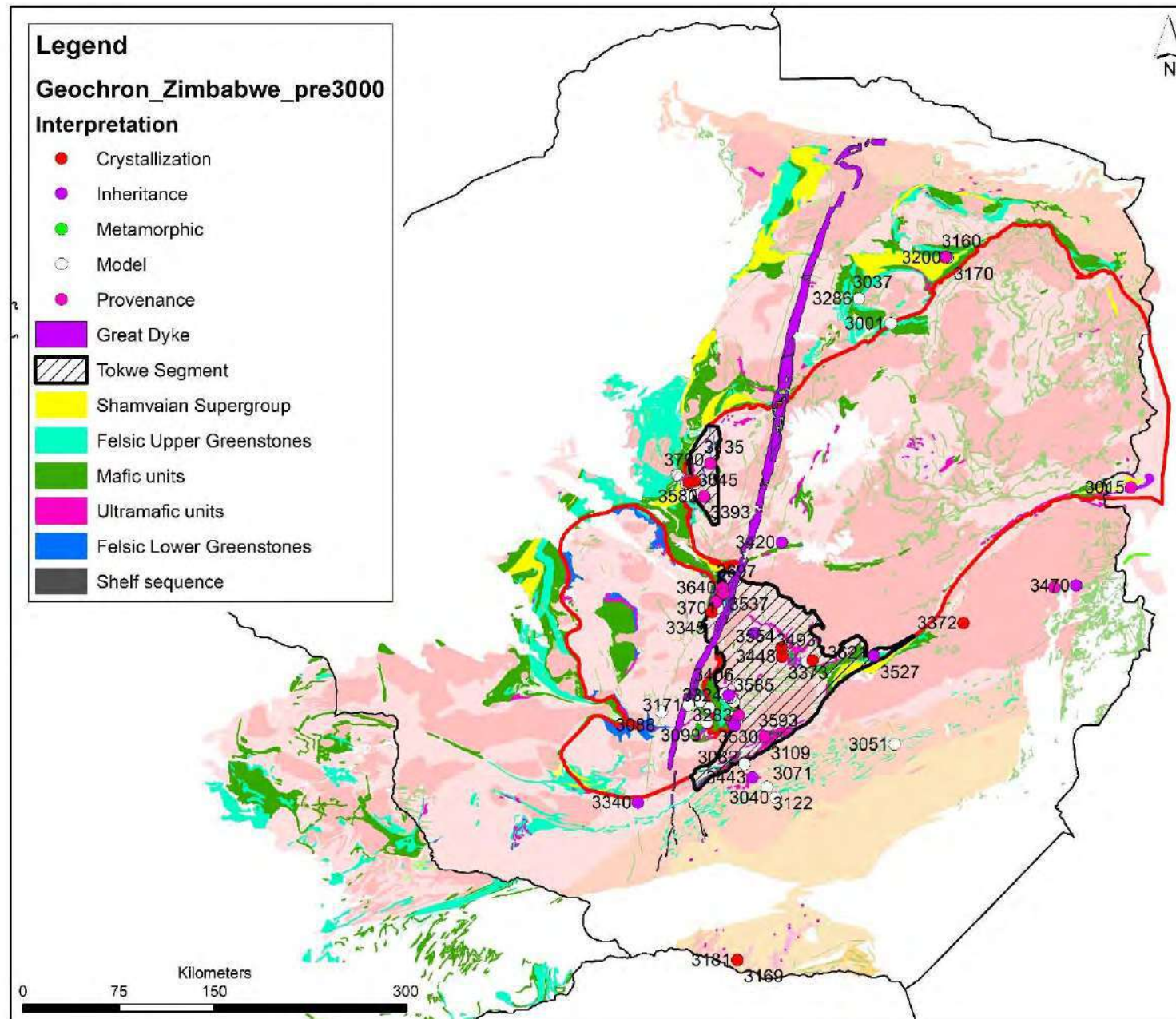


*Nesbitt et al. (2000)
Presentation in
Manchester*

*Jelsma and Barton ,
unpublished data*

UNTANGLING THE STRATIGRAPHY

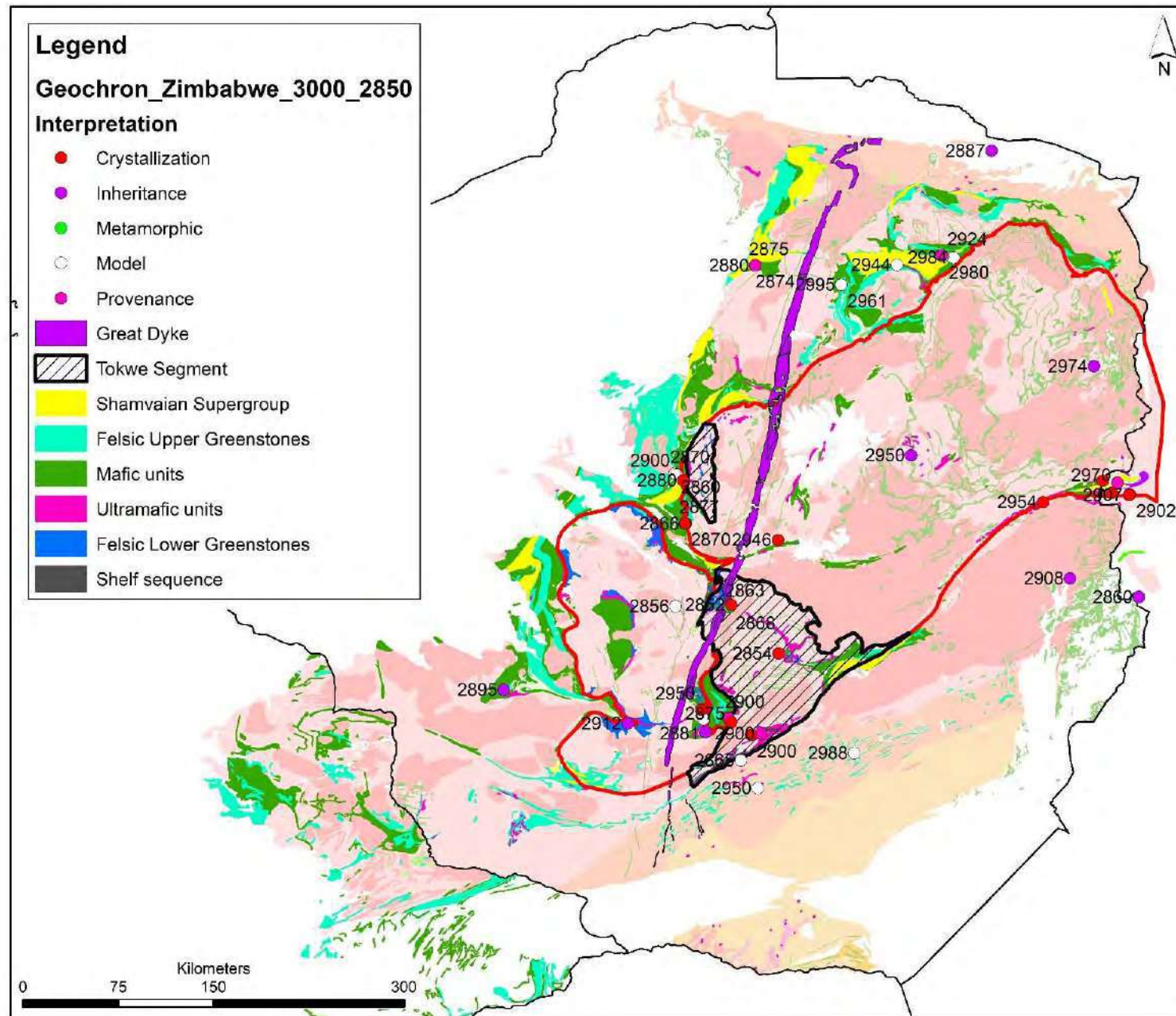
Zimbabwe Craton: Pre-3000 Ma



*Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019*

UNTANGLING THE STRATIGRAPHY

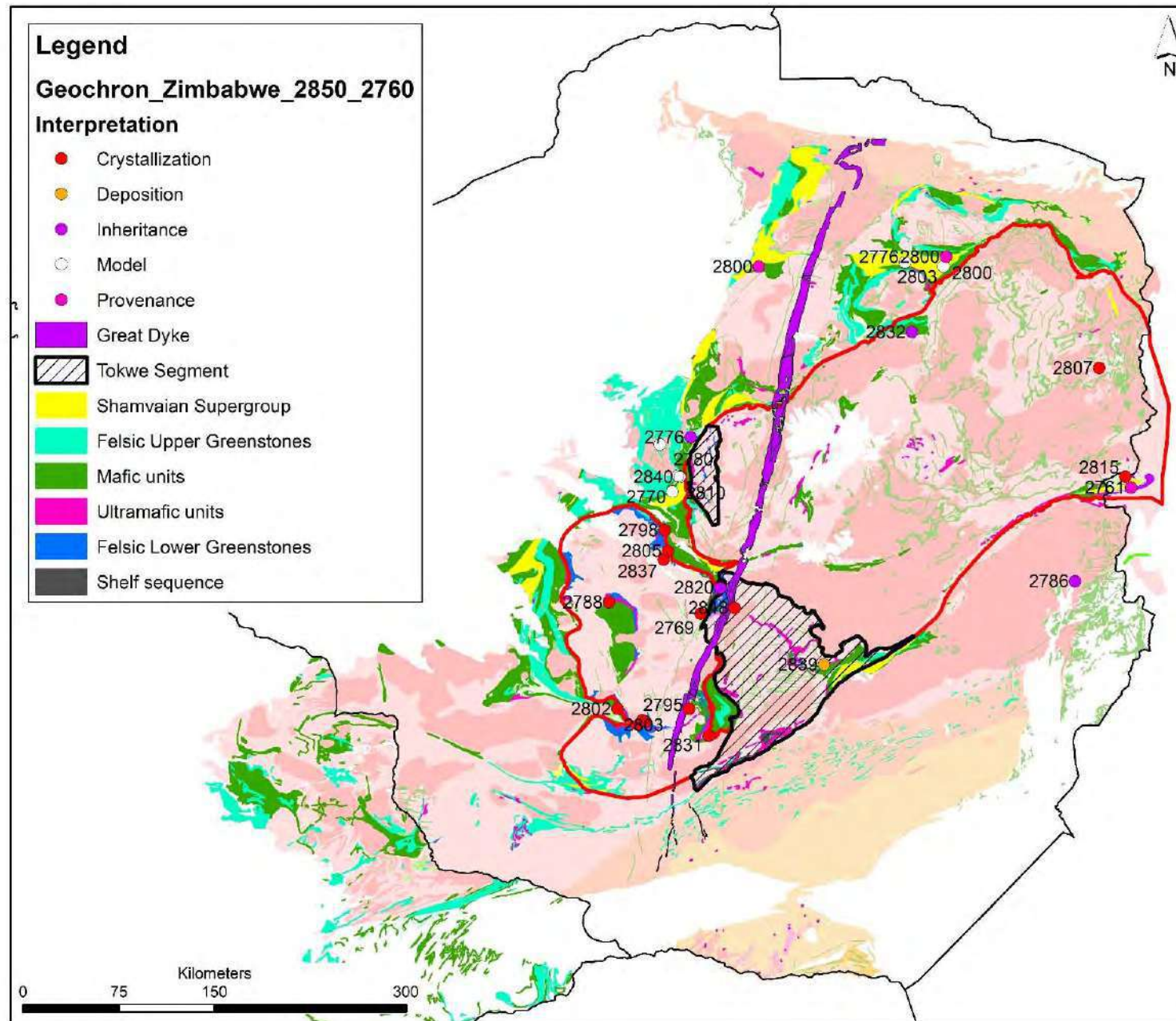
Zimbabwe Craton: 3000-2850 Ma



*Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019*

UNTANGLING THE STRATIGRAPHY

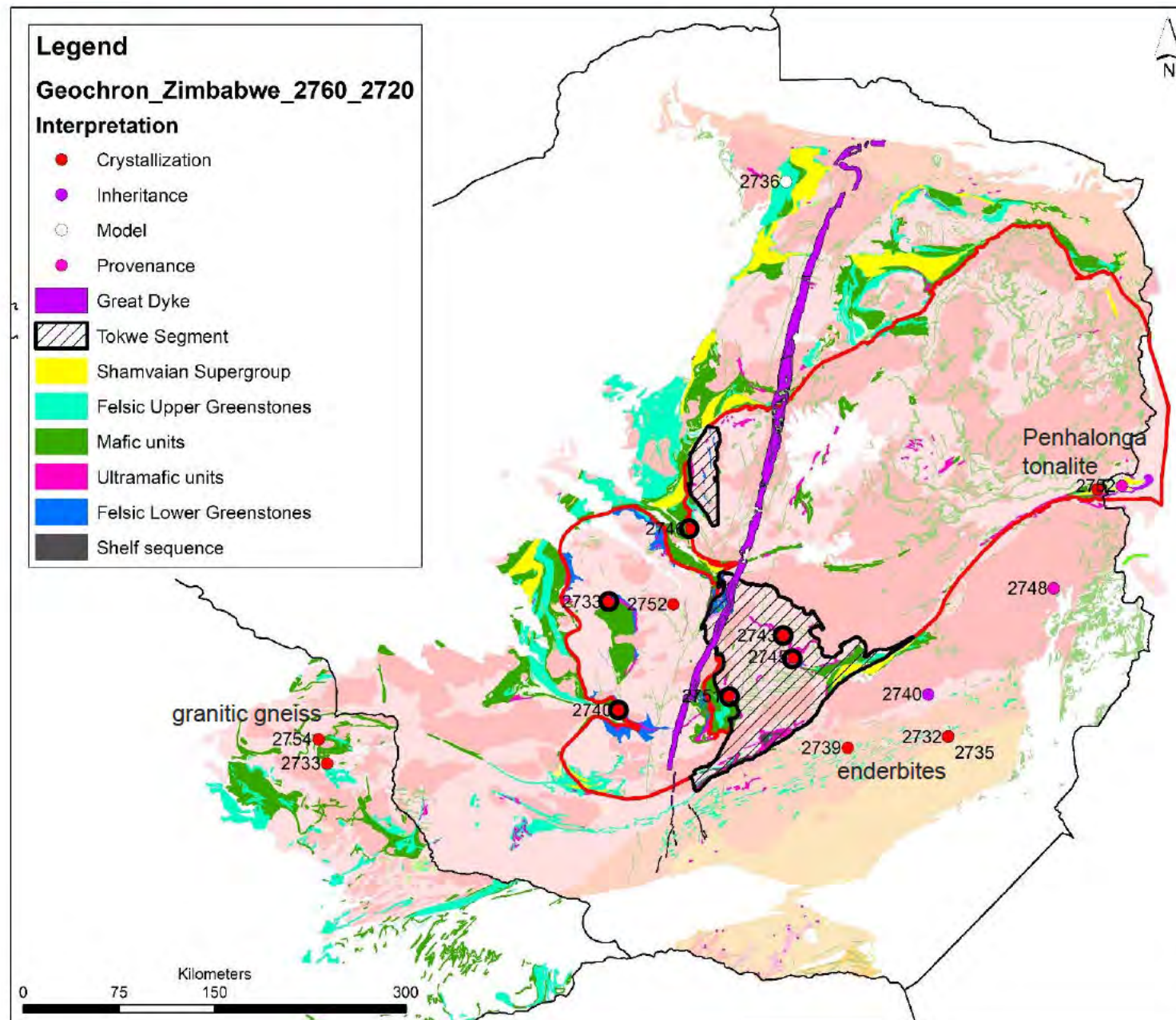
Zimbabwe Craton: 2850-2760 Ma



Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019

UNTANGLING THE STRATIGRAPHY

Zimbabwe Craton: 2760-2720 Ma

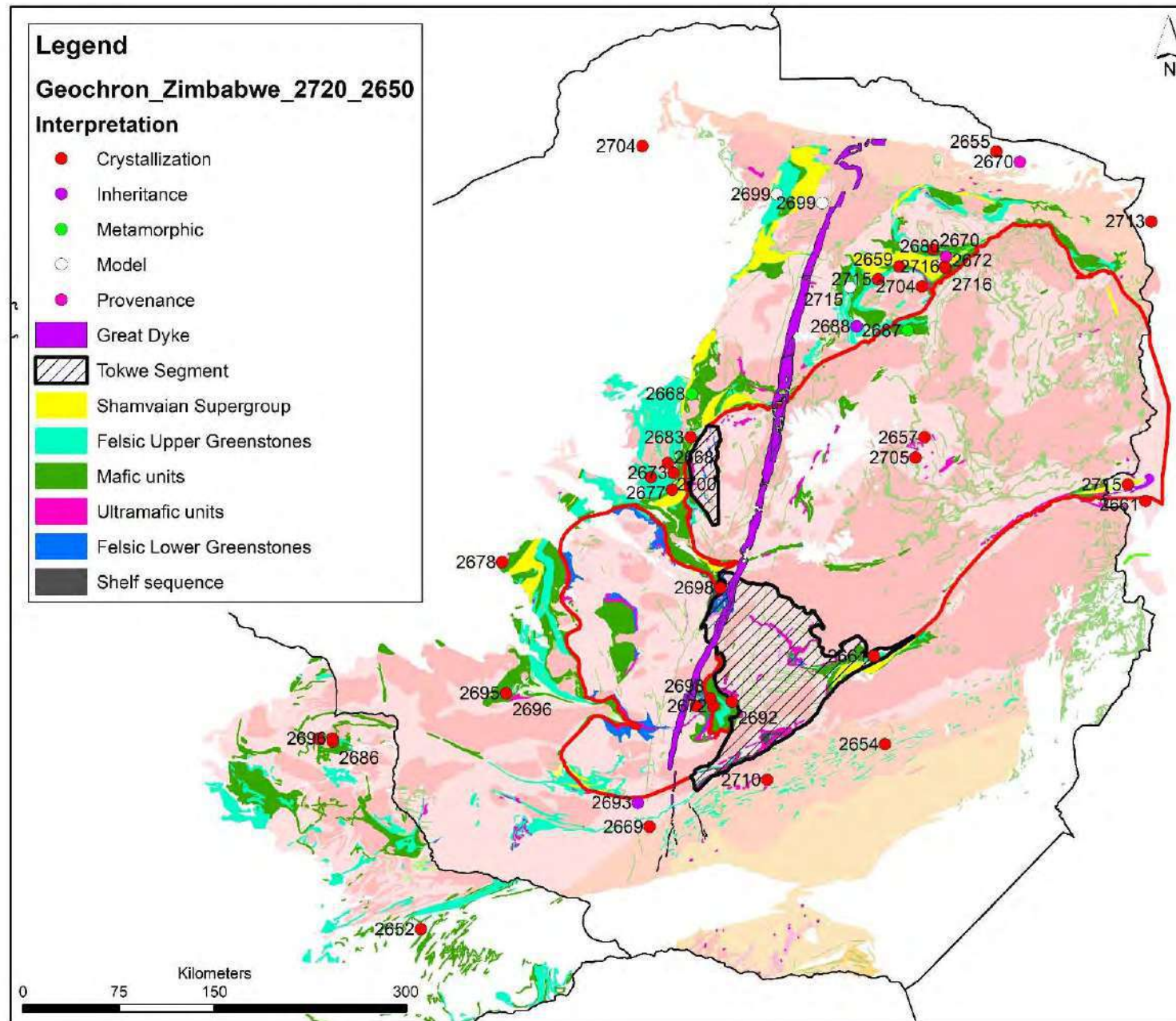


*Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019*

- Reliance(U2)
komatiitic event
(Prendergast
and Wingate
2013)

UNTANGLING THE STRATIGRAPHY

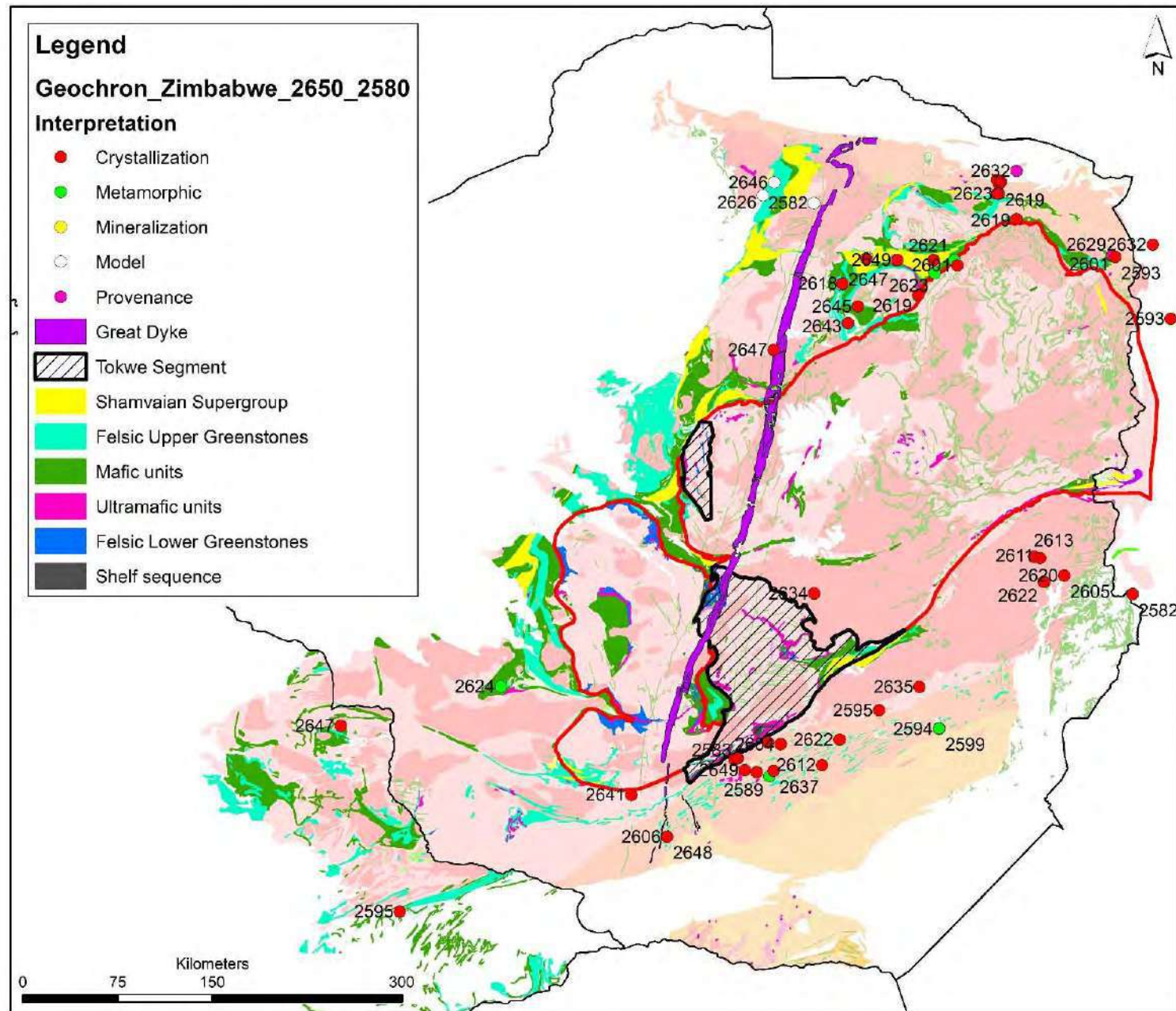
Zimbabwe Craton: 2720-2650 Ma



*Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019*

UNTANGLING THE STRATIGRAPHY

Zimbabwe Craton: 2650-2580 Ma



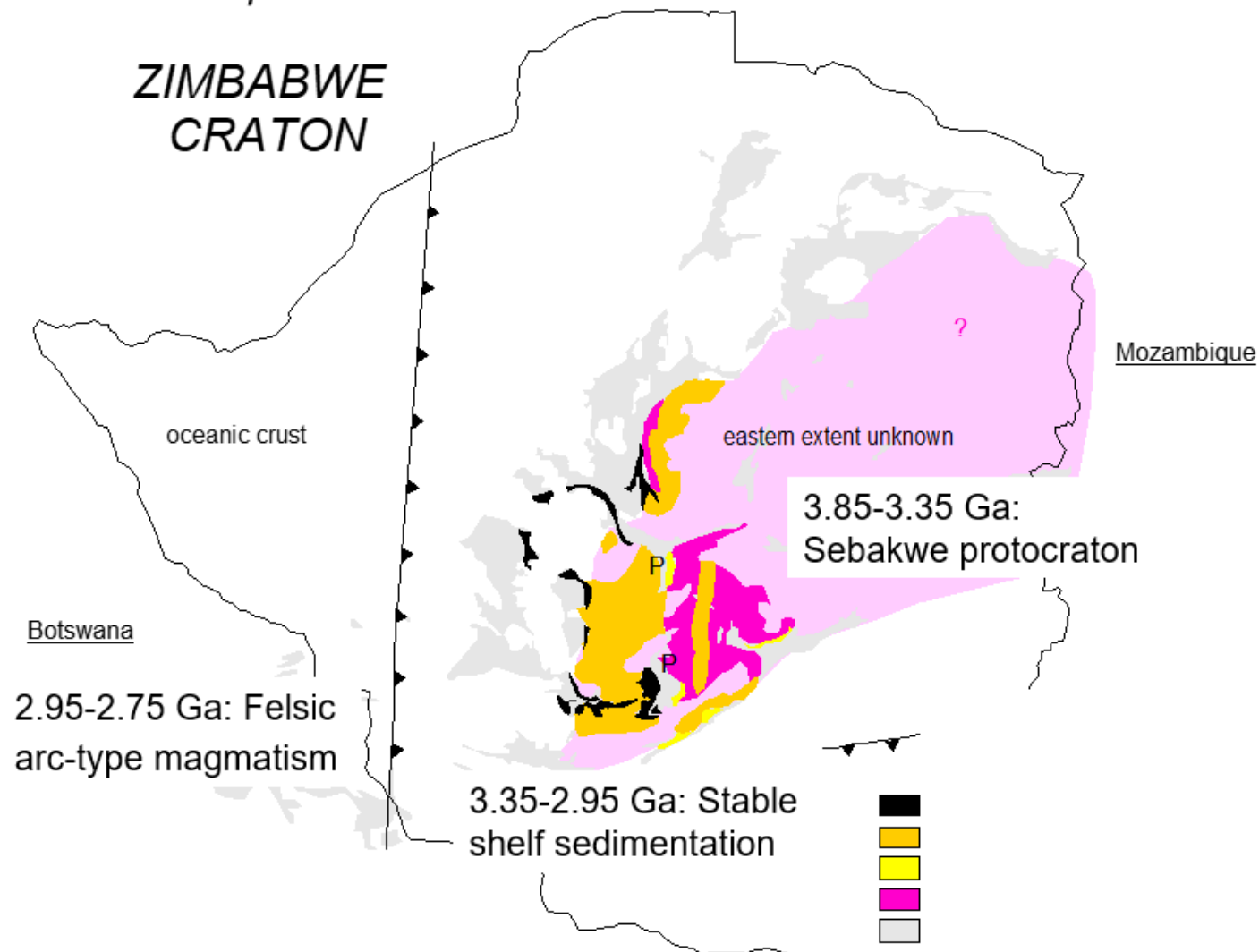
*Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019*

GEODYNAMIC SETTING

Zimbabwe Craton: 3.5-2.8 Ga time period



CRATON FORMATION
3.5-2.8 Ga time period



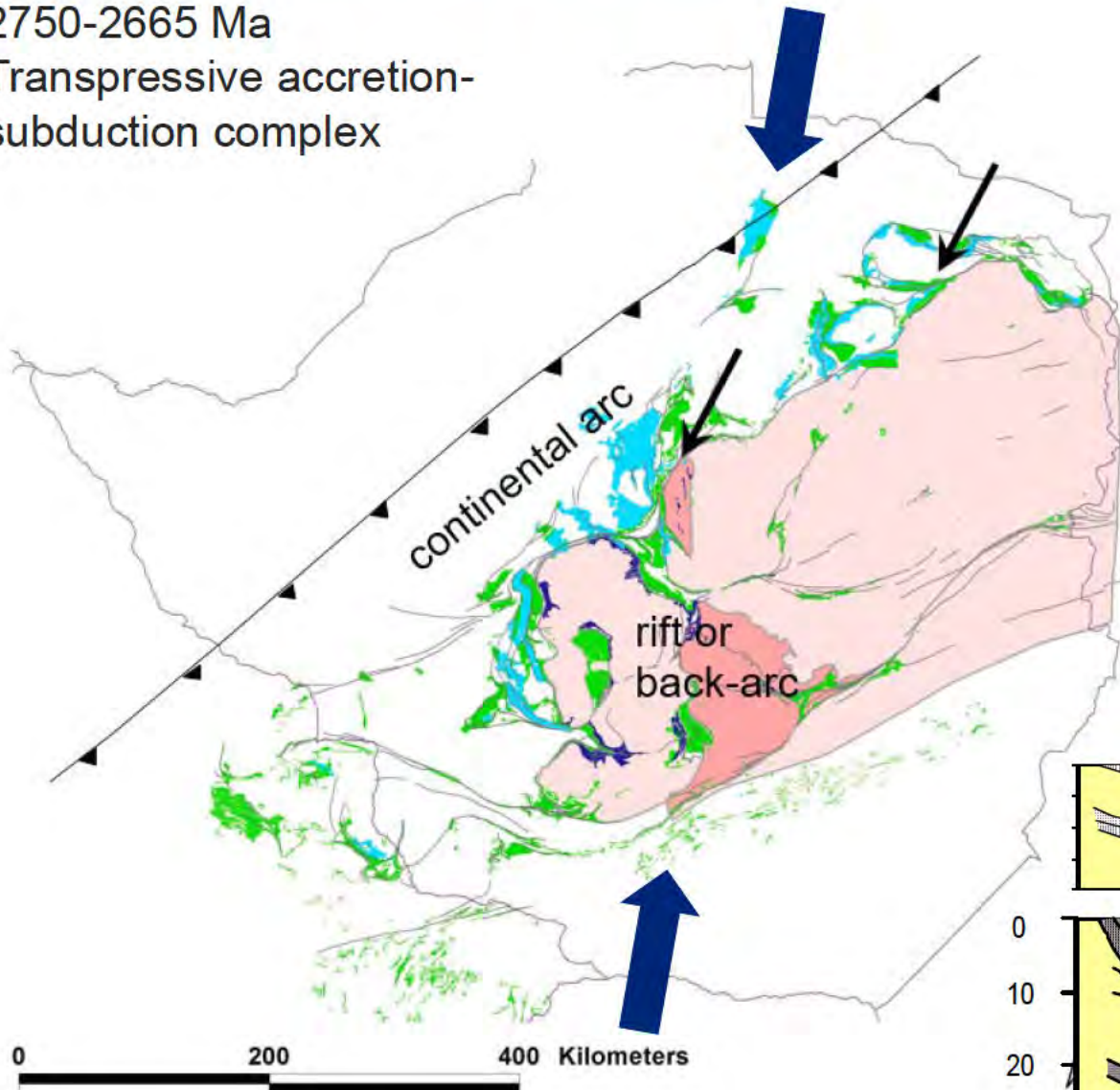
GEODYNAMIC SETTING

Zimbabwe Craton: 2.7-2.6 Ga time period



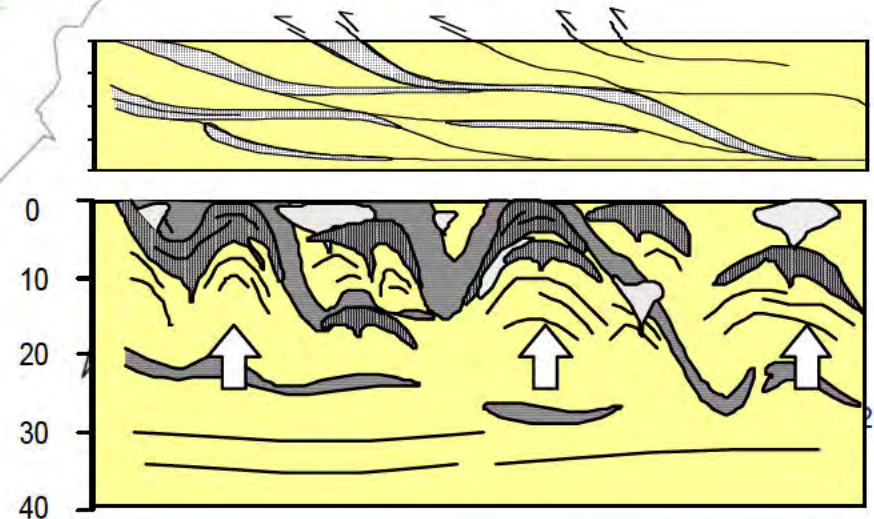
2750-2665 Ma

Transpressive accretion-subduction complex



(2) >800 km long NE-SW arc: Calcalkaline (predominantly basaltic-rhyolitic) magmatism constrained between 2715-2645 Ma, including several generations of porphyries

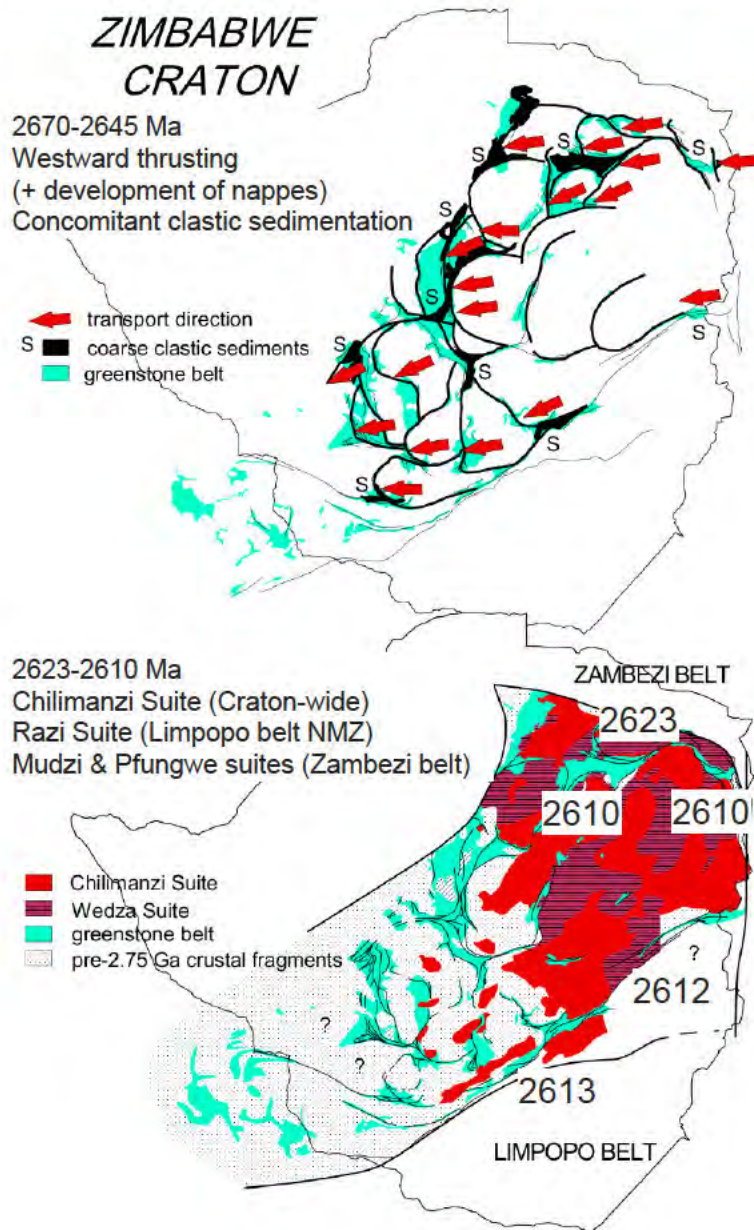
(1) Rift-type volcanism and sedimentation
Komatiitic-basaltic andesitic magmatism within Sebakwe proto-craton constrained between 2760-2700 Ma:



modified after Jelsma and Dirks 2002

GEODYNAMIC SETTING

Zimbabwe Craton: 2.7-2.6 Ga time period



2665-2650 Ma
Westward thrusting
Concomitant clastic sedimentation

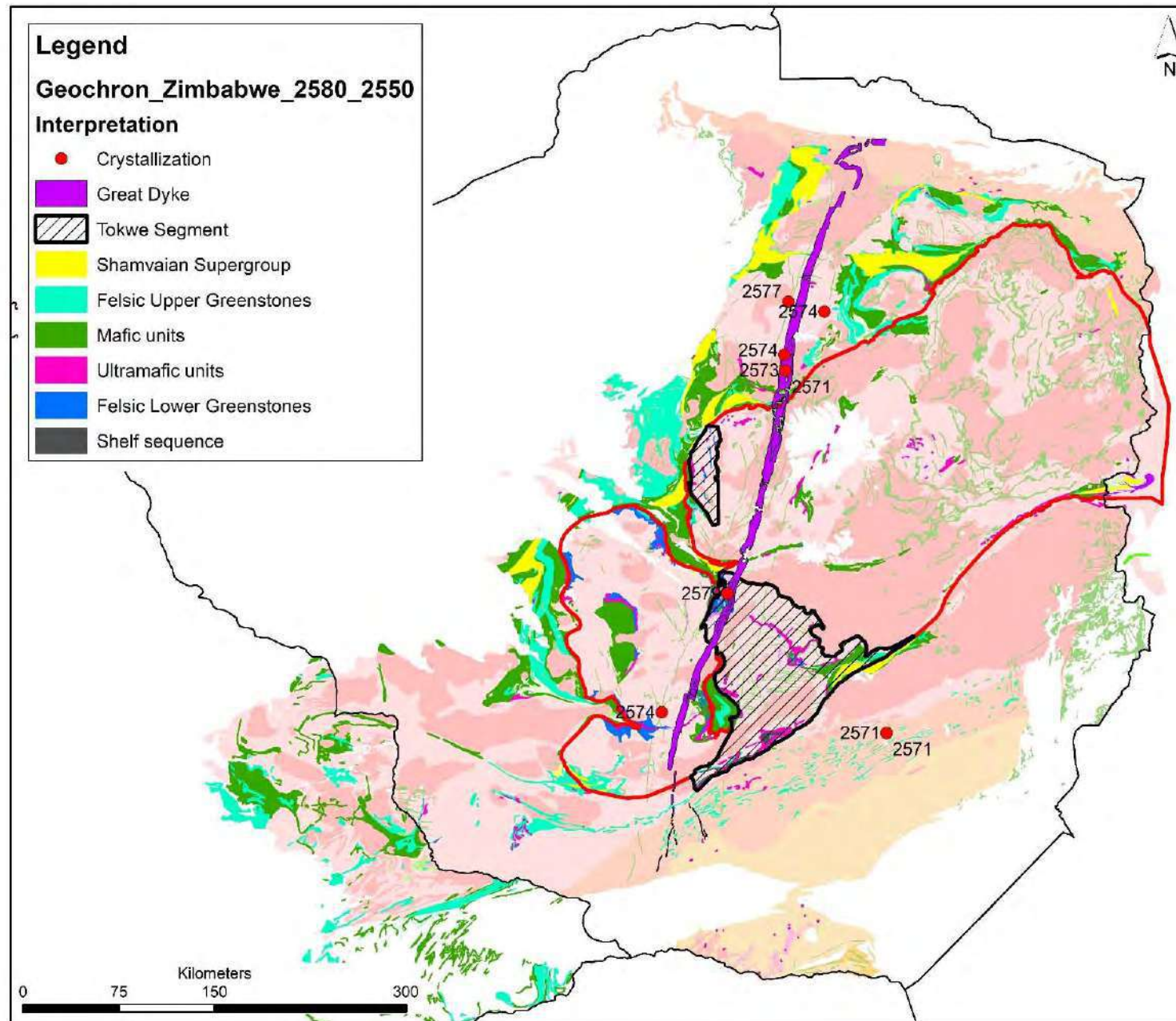
2650-2610 Ma
Emplacement of late-/post-tectonic granites
Metamorphic ages
Gold mineralization

2600-2580 Ma
Magmatic shutoff and cratonization

2575 Ma
Emplacement of the Great Dyke, the (satellite)
Umvimeela and East dykes and associated
fracture set

GEODYNAMIC SETTING

The Great Dyke Event at 2575 Ma



*Zimbabwe
Geochronology Data
Compilation,
Jelsma 2019*

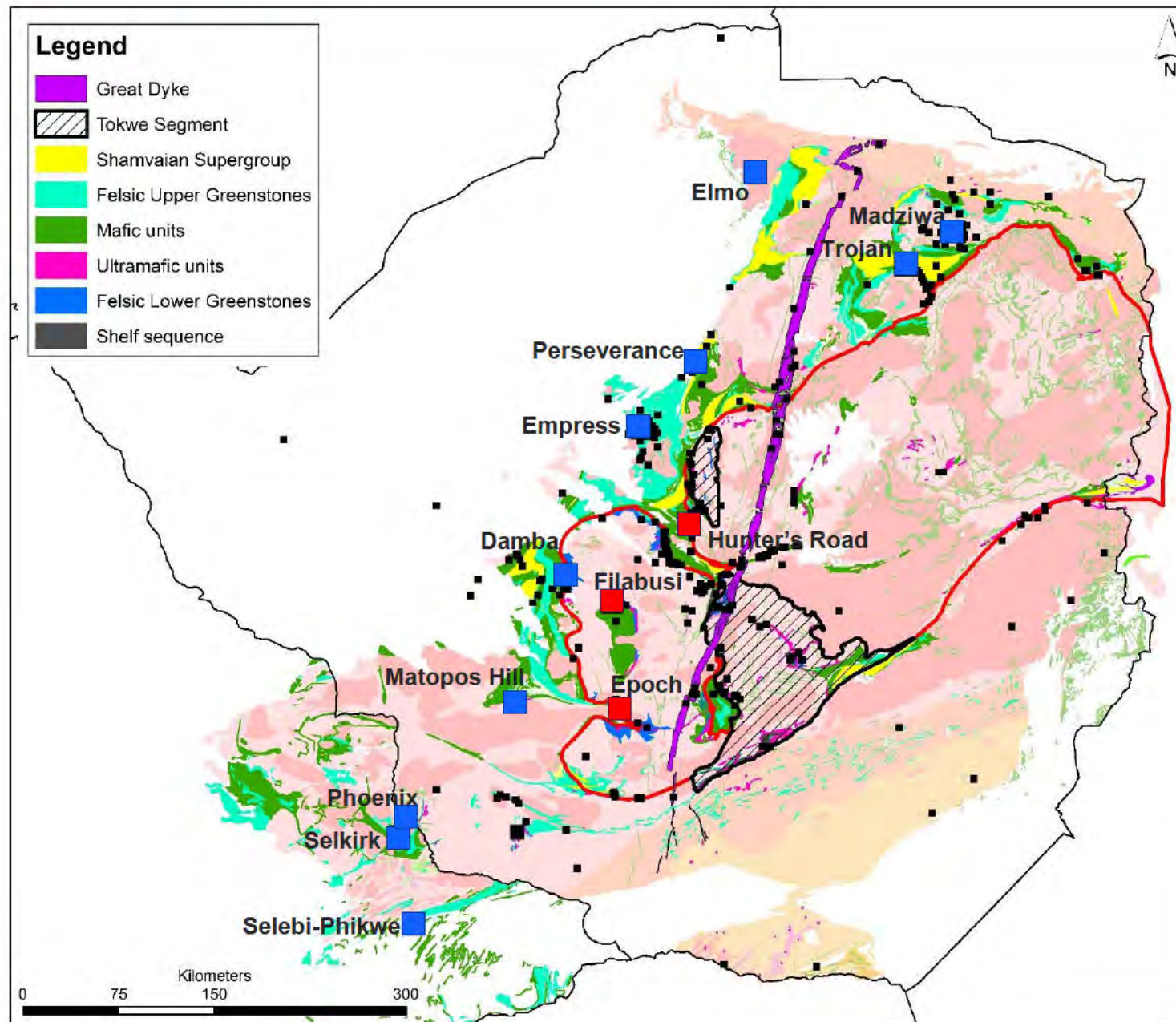
*Great Dyke:
2574 Ma*

*Umvimeela Dyke:
2575 Ma*

*East Dyke
2574 Ma*

MINERAL ENDOWMENT

Nickel in Zimbabwe Craton



Zimbabwe Nickel
Data Compilation
(est. 450,000 t Ni),
Jelsma 2019,
modified after
Bartholomew 1991

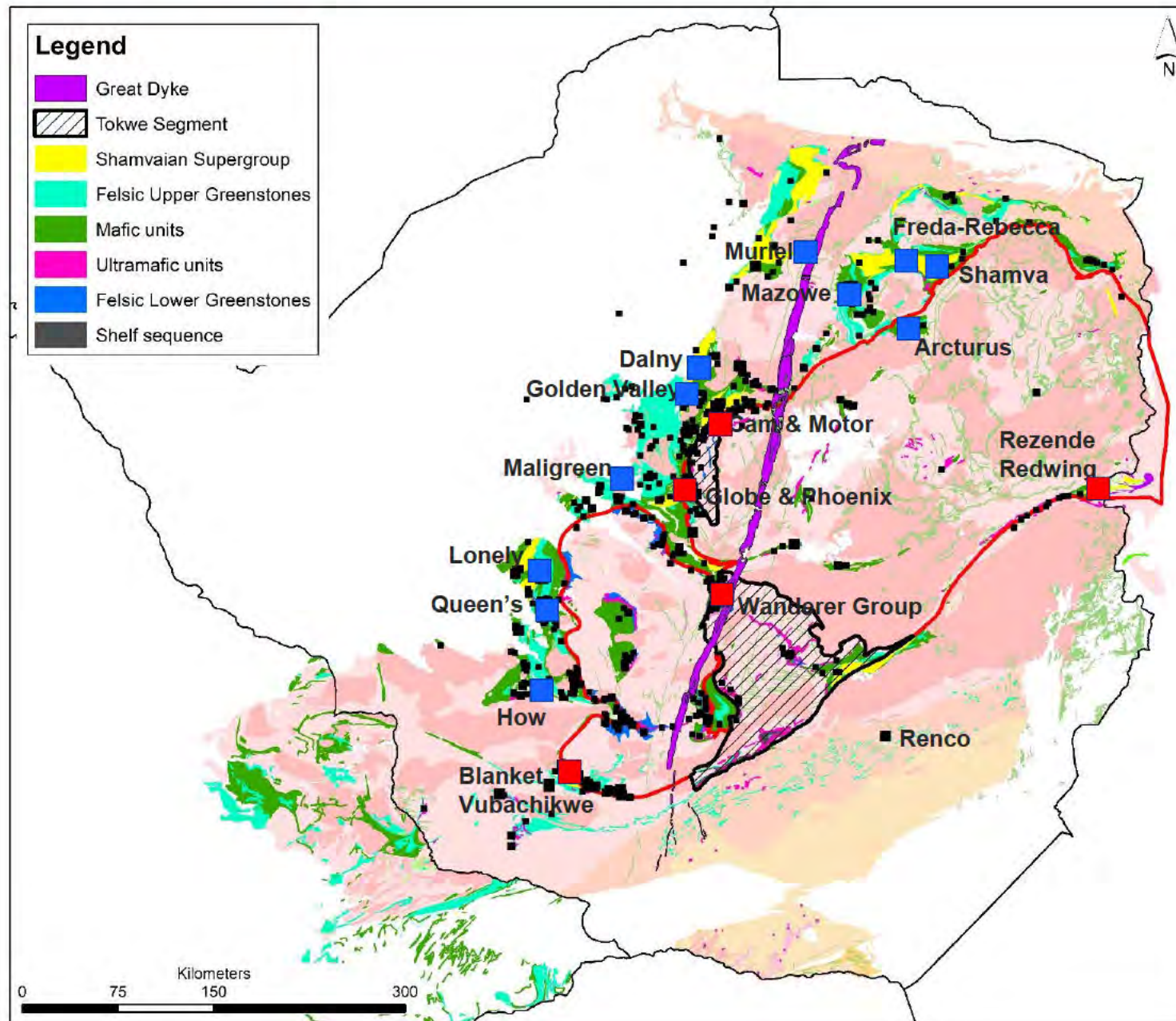
Two age groupings?
~2.74 Ga
~2.70 Ga

Need for systematic
age constraints on
(ultra)mafic host
rocks **using zircon
and baddeleyite**

■ 2.74 Ga (Ni)
■ 2.70 Ga (Ni-Cu)

MINERAL ENDOWMENT

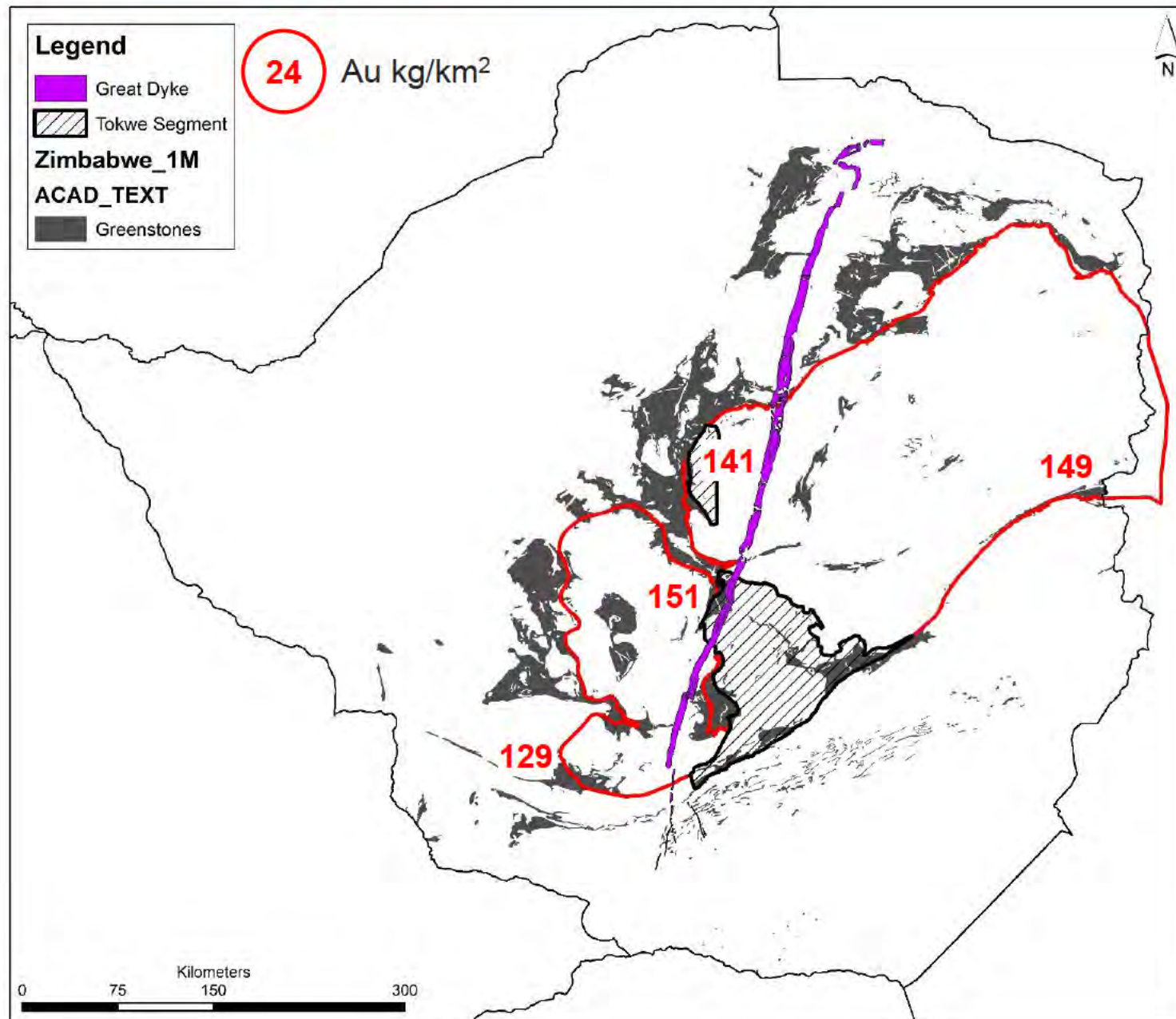
Gold in Zimbabwe Craton



*Zimbabwe Gold
Data Compilation
(est. 2,000 t Au),
Jelsma 2019,
modified after
Bartholomew 1991*

MINERAL ENDOWMENT

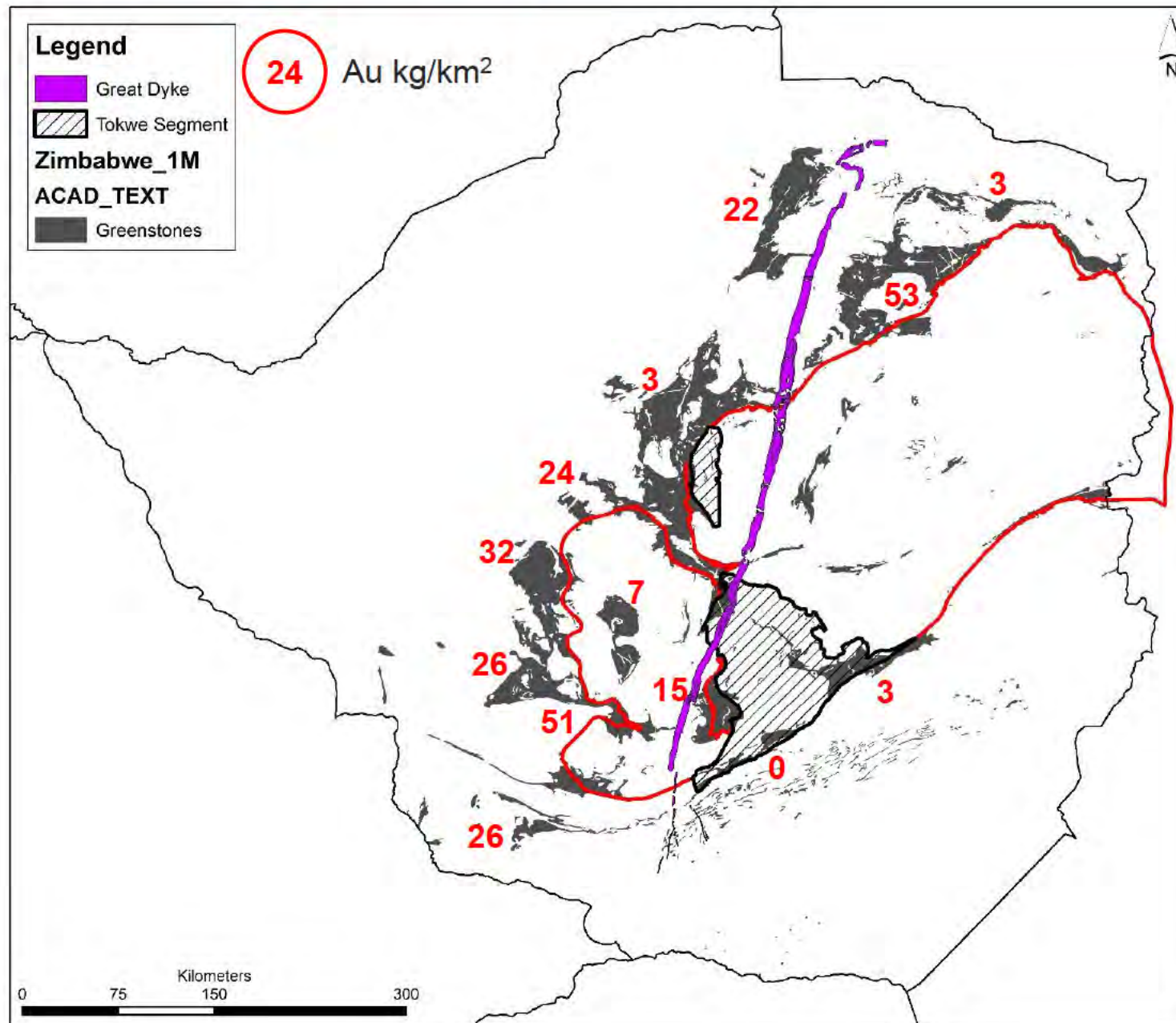
Gold in Zimbabwe Craton: Fertile Belts



*Zimbabwe Gold
Data Compilation
(est. 2,000 t Au),
Jelsma 2019,
modified after
Bartholomew 1991*

MINERAL ENDOWMENT

Gold in Zimbabwe Craton: Less Fertile Belts



Zimbabwe Gold
Data Compilation
(est. 2,000 t Au),
Jelsma 2019,
modified after
Bartholomew 1991

CONCLUDING REMARKS



- Macgregor's maps changed the course of geological thinking in southern Africa.
- His passion is to be continued. Mapping is **the** cornerstone of investigations in our field.
- Need for isotope studies (terranechron mapping) and high precision geochronology

Outstanding Questions

Ensialic versus oceanic origin of Belingwe belt volcanics	Work by Prendergast?
Nature of contacts between the Manjeri and Reliance Formations?	Sheared, with stratigraphic truncations
If the Reliance Formation komatiites and intrusives are 2740-2730 Ma in age, then they predate basal successions in other greenstone belts (and two generations of ultramafics + Ni)?	Yes, this underscores the presence of contrasting geodynamic settings
Do we see diachroneity of granitoids (Sesombi, Chilimanzi) and greenstones (felsic magmatism) from N to S?	With better data, this seems no longer the case
Have we resolved the geological framework of the Harare-Shamva belt?	Iron Mask, Passaford, Shamvaian probably
What is the age of the Thebus Formation?	Uncertain
What is the significance of a 2832 Ma age from a felsic unit near Arcturus Mine (Mutemeri)?	Interpreted as tectonic sliver, cf. Sebakwe Gneiss

A.M. MACGREGOR



Bulletins

- Macgregor A.M. (1921). The geology of the diamond-bearing gravels of the Somabula Forest. S. Rhod. geol. Surv. Bull. 8, 48p.
- Macgregor A.M. (1928). The geology of the country around the Lonely Mine, Bubi District. S. Rhod. geol. Surv. Bull. 11, 96p.
- Macgregor A.M. (1930). The geology of the country between Gatooma and Battlefields. S. Rhod. geol. Surv. Bull. 17, 144p.
- Macgregor A.M. (1932). The geology of the country around Que Que, Gwelo District. S. Rhod. geol. Surv. Bull. 20, 113p.
- Macgregor A.M. (1935). The geology of the Makaha Gold Belt, Mtoko District. S. Rhod. geol. Surv. Bull. 28, 46p.
- Macgregor A.M., Ferguson J.C. and Amm F.L. (1937). The geology of the country around the Queen's Mine, Bulawayo District. S. Rhod. geol. Surv. Bull. 30, 179p.
- Macgregor A.M. (1937). The geology of the country around Hunters Road, Gwelo District. S. Rhod. geol. Surv. Bull. 31, 78p.
- Macgregor A.M. (1947). An outline of the geological history of Southern Rhodesia. S. Rhod. geol. Surv. Bull. 38, 73p.

Short Reports:

- Maufe H.B. and Macgregor A.M. (1920). Second interim report on the geology of part of the Bembesi Basin. S. Rhod. geol. Surv. Short Rep. 9.
- Macgregor A.M. (1921). Third interim report on the geology of part of the Bembesi Basin. S. Rhod. geol. Surv. Short Rep. 11.
- Macgregor A.M. (1923). Preliminary Report on the Geology of the Country around the Lonely Mine. S. Rhod. geol. Surv. Short Rep. 14, 10p.
- Macgregor A.M. (1924). Interim Report on the Geology of the Country South of Umsweswe, Hartley District. S. Rhod. geol. Surv. Short Rep. 16, 18p.
- Macgregor A.M. (1925). Note of the geology of the Felixburg Goldfield. S. Rhod. geol. Surv. Short Rep. 18
- Macgregor A.M. (1927). A geological reconnaissance of the Mafungabusi Gold Belt. S. Rhod. geol. Surv. Short Rep. 20
- Macgregor A.M. (1931). The geology of the country around the Norah, Molly and Umboe copper claims, Lomagundi District. S. Rhod. geol. Surv. Short Rep. 25
- Macgregor A.M. (1941). The geology of the Mafungabusi Gold Belt. S. Rhod. geol. Surv. Short Rep. 35.

Selected papers:

- Macgregor A.M. (1915). Notes on a graphic intergrowth of diopside and ilmenite from the Bembesi Diamond Field, Southern Rhodesia. Trans. Geol. Soc. S. Afr. 18, 1-4
- Macgregor A.M. (1917). The Karoo rocks and later sediments north-west of Bulawayo. Trans. Geol. Soc. S. Afr. 19, 20p.
- Macgregor A.M. (1932). Batholiths of Southern Rhodesia. Geological Magazine 69, 18-28.
- Macgregor A.M. (1941). A Precambrian algal limestone in southern Rhodesia. Trans, Geol. Soc. S. Afr. 43, 9-15.
- Macgregor A.M. (1949). The influence of life on the face of the Earth. Presidential Address, Rhodesia Scientific Association. Proceedings and Transactions 17, 5-11.
- Macgregor A.M. (1951). Some milestones in the Precambrian of Southern Rhodesia. Proc. Geol. Soc. S. Afr. 54, 27-71.

THANK YOU