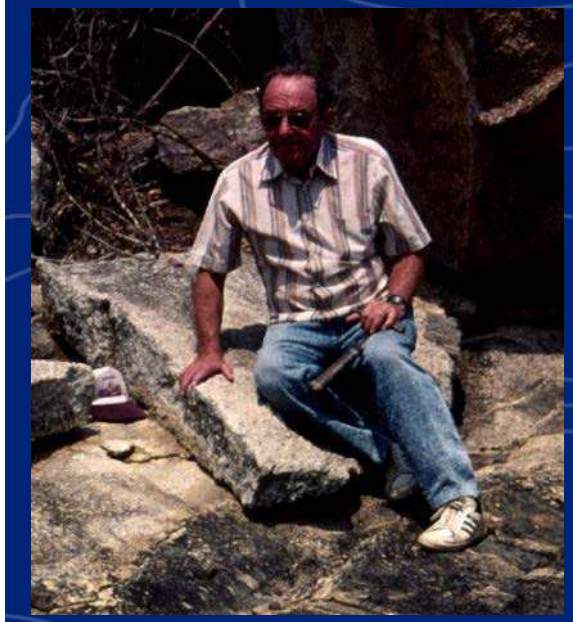
A REASSESSMENT OF THE GEODYNAMIC EVOLUTION OF THE ZIMBABWE CRATON

A long journey with Bob Nesbitt and Mark Fanning

Geological Society of Zimbabwe, 9 October 2020



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INTRODUCTION

Southern Africa

1. Introduction
2. Archean geology of Zimbabwe
3. Geochronology: Previous and unpublished geochronology
4. “Untangling the Stratigraphy” - towards a new Provisional Stratigraphic Table
5. Relevance for the Mineral Endowment of the Zimbabwe Craton

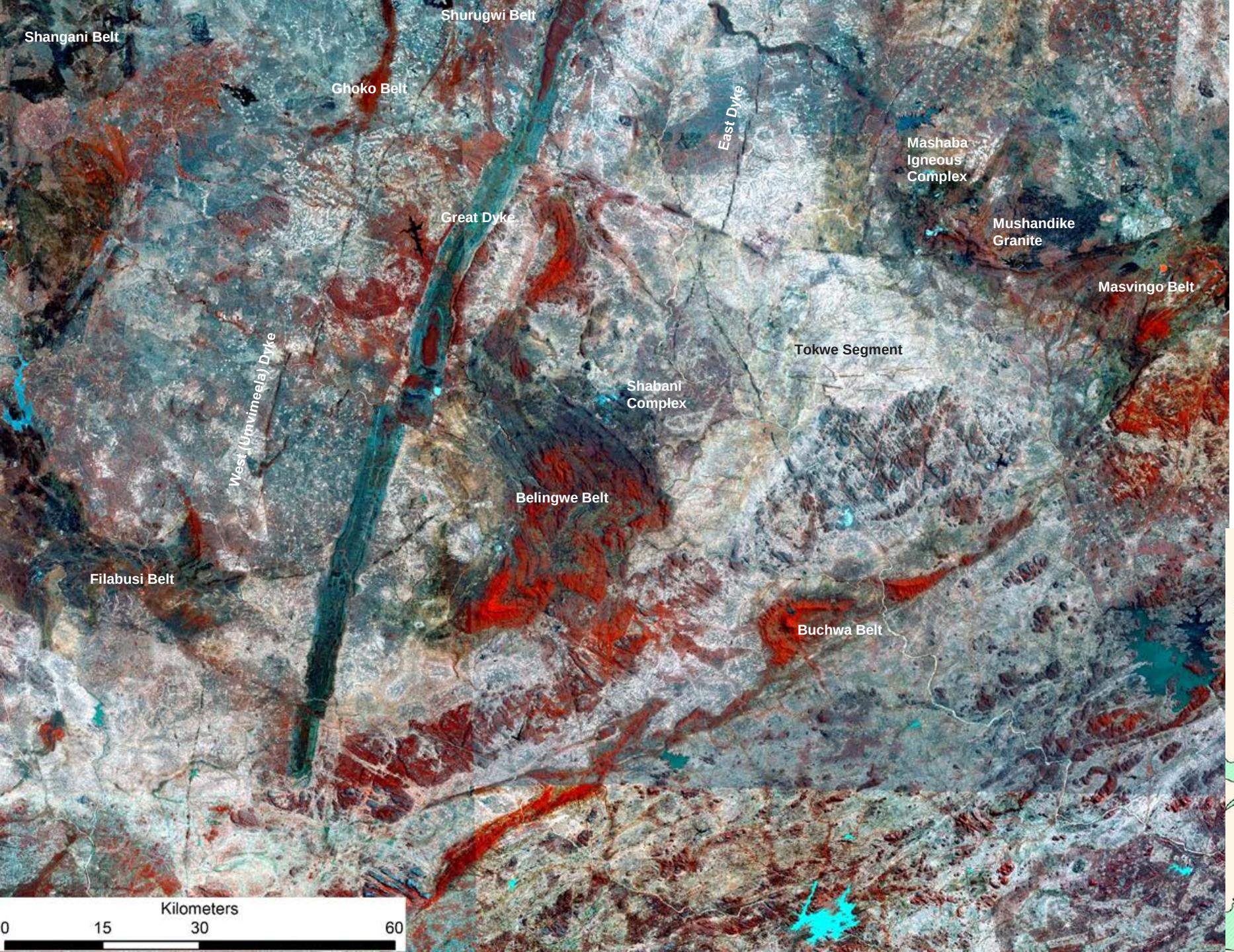
Rationale: This work was spawned from an invitation by GSZ to present the 11th A.M. Macgregor Memorial Lecture in 2019. The presentation and resultant manuscript (Jelsma, Nesbitt and Fanning, South African Journal of Geology) examine our current understanding of the geological evolution and mineral endowment of the Zimbabwe Craton using new and existing geochronology data.

It builds on the work of collaborators, two of whom have sadly passed away (Michael Vinyu in 2000 and Jim Wilson in 2016) and includes unpublished original data from the seminal paper by Wilson et al. (1995) subsequent reanalysis of six samples using SRIMP zircon in 1997, so that this information is not lost to science, as much of this data is unique and irreplaceable.

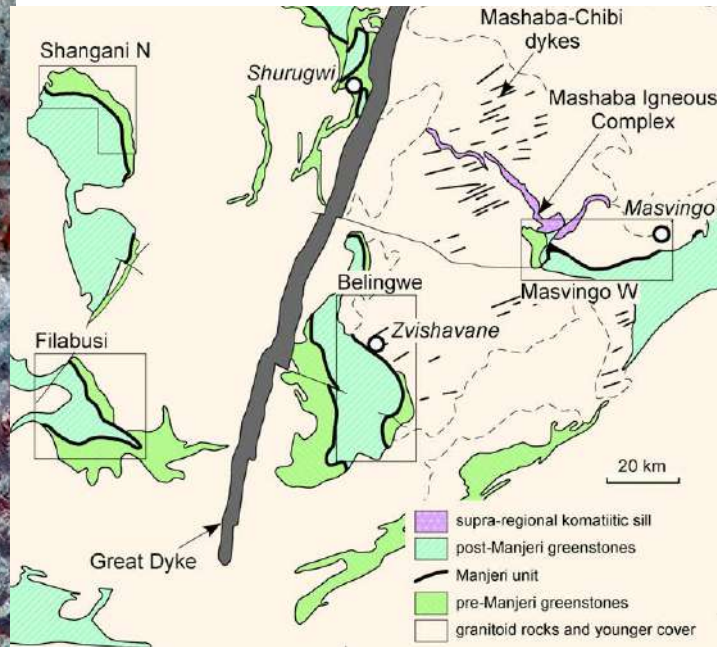
Acknowledgements: The late Jim Wilson and Mike Vinyu are remembered for their friendship and research collaboration and some of the samples relate to their earlier work. Bob acknowledges Natural Environment Research Council (NERC) for a 1992 grant to conduct fieldwork in Zimbabwe and SHRIMP analytical work at ANU in Canberra. Hielke wishes to thank the Geological Society of Zimbabwe for the invitation to present the 11th Macgregor Memorial Lecture which provided the needed inspiration to finish the work. Peter Fey, Tim Broderick, Brent Barber, Tony Martin, Forbes Mugumbate, Houda Bouammar, Collins Mwatahwa and Caston Musa are thanked for inputs to and support with the Lecture series in 2019. John Vann (Anglo American Group Discovery & Geosciences) and Charles Skinner and Julie Kong (De Beers Exploration) for time and sharing unpublished material collected with Erika Barton in eastern Zimbabwe.

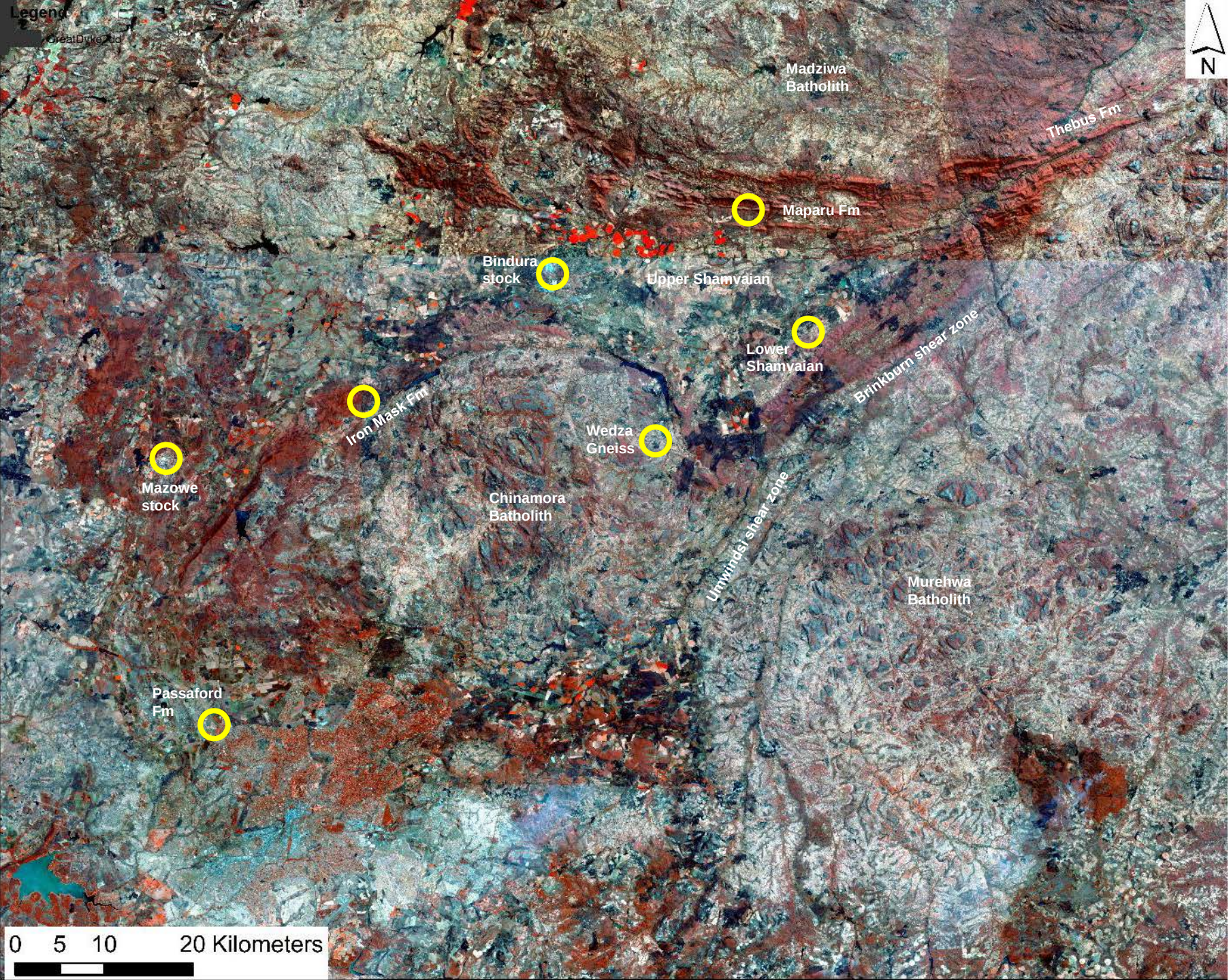
A TRIPARTITE SUBDIVISION

Macgregor, 1947	Stagman, 1978	Wilson, 1979			Wilson et al. 1995			Geochronology	Intruded by:
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 clastic deposits	Shamvaian Group	Shamvaian Group			Shamvaian Supergroup	Upper Shamvaian Group		>2647 Ma	Bindura granodiorite: 2647 Ma
						Lower Shamvaian Group	Harare Sequence	Passaford Fm: 2643 ± 8 Ma	Chilimanzi Suite: 2620 Ma Glendale tonalite: 2618 Ma Mazowe granodiorite: 2647 Ma
							H marker		
							U6 ?	Lake Kyle vent: 2661:Ma Porphyries: 2666-2661 Ma	
Lower Series: Bulawayan System mafic-felsic	Upper Bulawayan	Bulawayan Group	Upper Greenstones	Maliyami Fm	Bulawayan Supergroup	Upper Bulawayan Group	U5	Maliyami Fm: 2702 Ma	Sesombi tonalite: 2672 Ma
				Cheshire Fm			U4W/U4E	What Cheer Fm: 2683 Ma Avalon Fm: 2696 Ma Maparu Fm: 2697 Ma	Mashaba-Chibi dykes: 2700 Ma
				Zeederbergs Fm			U3	Surprise Fm: 2698 Ma Zeederbergs Fm	
				Reliance Fm			U2	Reliance Fm: 2745 Ma Sills: 2740-2733 Ma (Phurombuzi, Shangani)	
				Manjeri Fm			U1	Iron Mask Formation: 2712 Ma Manjeri Formation: >2745 Ma	Wedza gneiss: 2704 Ma Mutare tonalite: 2741 Ma
			Manjeri unconformity			M marker			
	Lower Bulawayan		Lower Greenstones	Koodoovale Fm		Lower Bulawayan Group	L4	Koodoovale Fm: 2803-2788 Ma Arizona Fm: 2805 Ma Eldorado Fm: 2799-2788 Ma	Somabula tonalite: 2752 Ma Gwenoro Dam gneiss: 2769 Ma
				K marker		K marker			
				Bend Fm	Belingwean Supergroup	Upper Belingwean Group	L3	Brooklands Fm Buchwa quartzite	
				B marker		B marker			
				Hokonui Fm		Lower Belingwean Group	L2	Mafic Fm: 2880-2870 Ma Redcliff Jaspillite Formation: 2870 Ma Hokonui Fm: 2904 Ma	Chingezi Suite: 2850-2837 Ma Ngezi tonalite: 2875 Ma
				Bvute Fm			L1	Manica felsic volcanics: 2990 Ma	Rhodesdale gneiss: 2946 Ma
Magnesian Series: Sebakwian System	Sebakwian Group	Sebakwian Group			Sebakwian Group			> 3375 Ma Shabani Gneiss: 3475 Ma Tokwe Gneiss: 3554 Ma Sebakwe River Gneiss: 3565 Ma	Mont d'Or granite: 3350 Ma Mushandike Granite: 3375 Ma



Sentinel
(832 bands)





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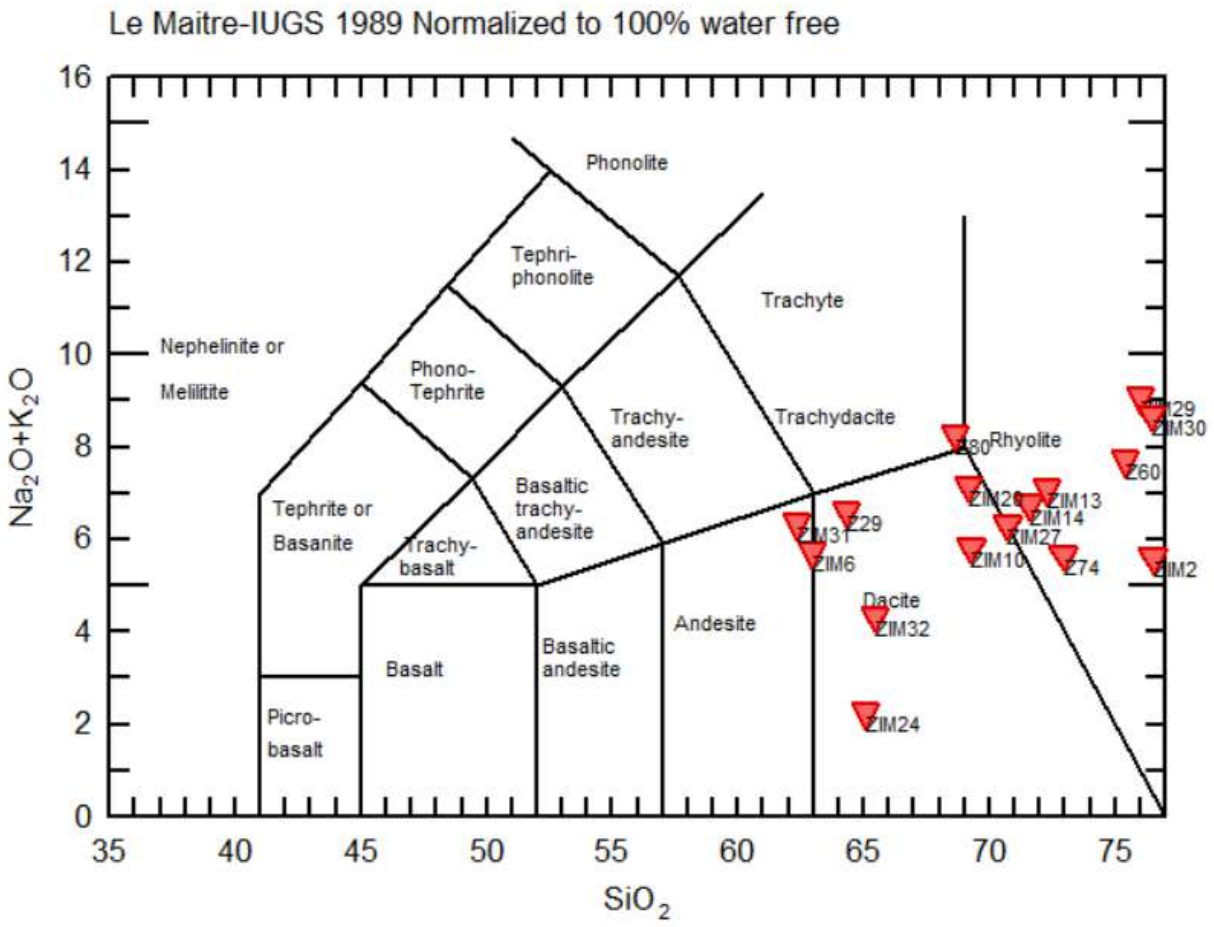
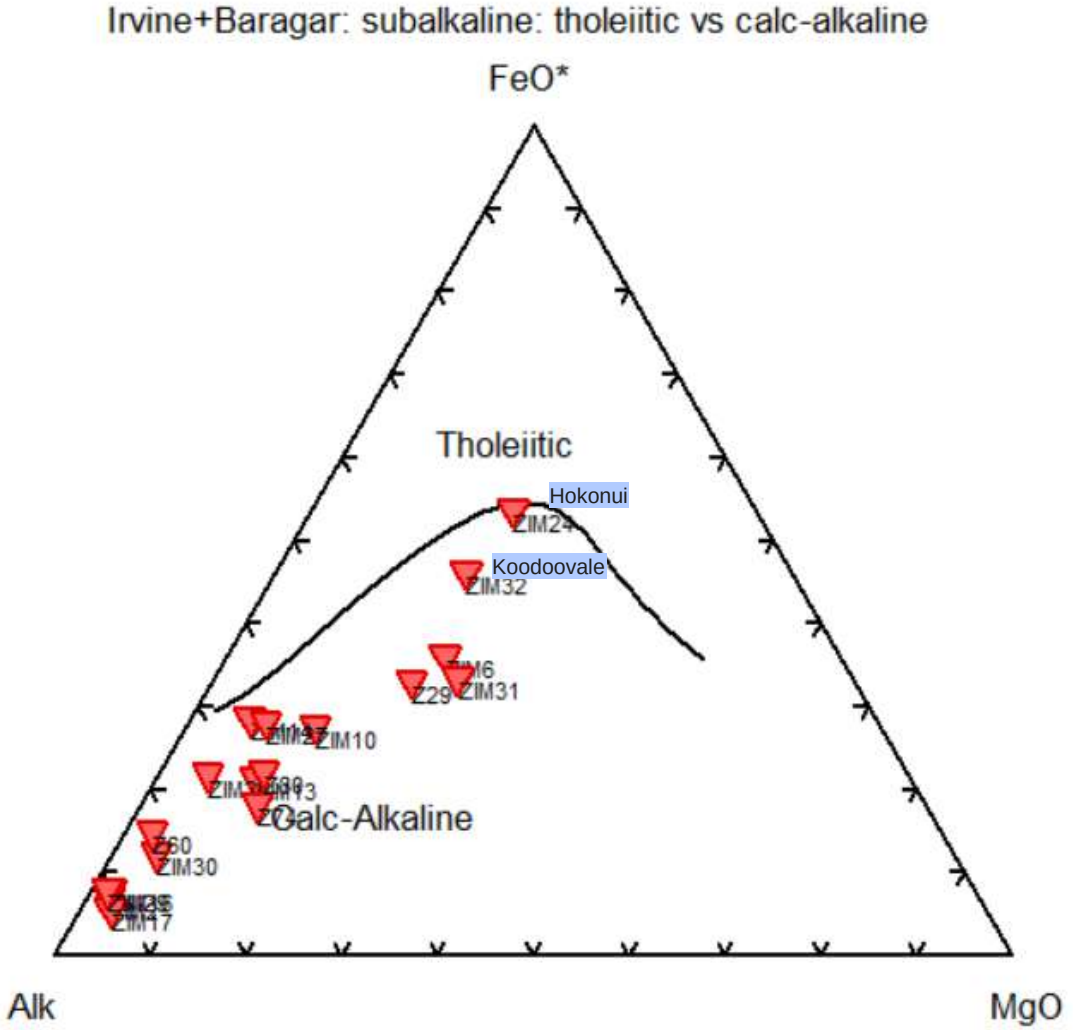
(832 bands)

GEOCHRONOLOGY SAMPLES

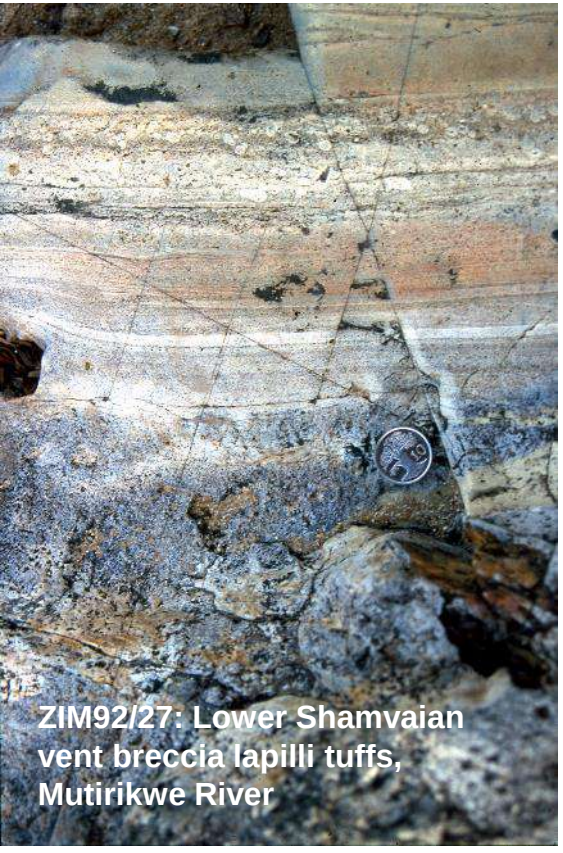
Sample	Xdd	Ydd	Unit	Lithology	Location
ZIM92/2	29.790	-18.530	What Cheer Fm	Rhyolite block in vent breccia	Nando area
ZIM92/6	29.510	-18.810	Maliyami Fm	Flow banded andesite	Gokwe
ZIM92/10	29.630	-19.330	Arizona Fm	Flow banded dacite	Arizona Mine
ZIM92/12	30.000	-19.590	Surprise Fm	Altered felsic volcanic	Railway cutting locality
ZIM92/13	28.490	-20.330	Avalon Fm	Rhyolite	page 53 in Garson (1995)
ZIM92/14	28.490	-20.330	Avalon Fm	Rhyolite	page 53 in Garson (1995)
ZIM92/16	29.470	-20.530	Eldorado Fm	Foliated rhyolite	Wynn's Mine
ZIM92/17	29.450	-20.520	Eldorado Fm	Flaggy rhyolite	Unkakezi River
ZIM92/20	29.860	-20.466	Hokonui Fm	Dacite block	Dohwe River
ZIM92/24	29.890	-20.470	Hokonui Fm	Dacite clast from volcanic breccia	Dohwe River
ZIM92/27	31.080	-20.070	Lower Shamvaian Gp	Flow banded rhyodacite block in vent breccia	Mutirikwe River
ZIM92/29	31.030	-17.630	Iron Mask Fm	Flow banded rhyolite	Ingleborough Estate
ZIM92/30	31.500	-17.210	Maparu Fm	Water-lain rhyolite tuff	Maparu Estate
ZIM92/31	30.960	-17.750	Passaford Fm	Andesite clast from volcanic breccia	Lomagundi Road
ZIM92/32	29.920	-20.630	Koodoovale Fm	Dacite clast from volcanic breccia	Belingwe Peak
Z/29	31.590	-17.340	Lower Shamvaian Gp	Dacite porphyry	Black Cat / Max Gold Mine
Z/60	31.420	-17.470	Wedza gneiss	Banded granite gneiss	The Vale Estate
Z/74	31.110	-17.420	Iron Mask Fm	Rhyolite flow	Iron Duke Mine
Z/79	30.920	-17.470	Mazowe stock	Late syn-tectonic granodiorite	Jumbo Gold Mine
Z/80	31.310	-17.300	Bindura stock	Late syn-tectonic granodiorite	Freda-Rebecca Gold Mine
ZIM97-01	31.580	-17.330	Lower Shamvaian Gp	Banded felsic tuff	Maxton Estate

GEOCHEMISTRY



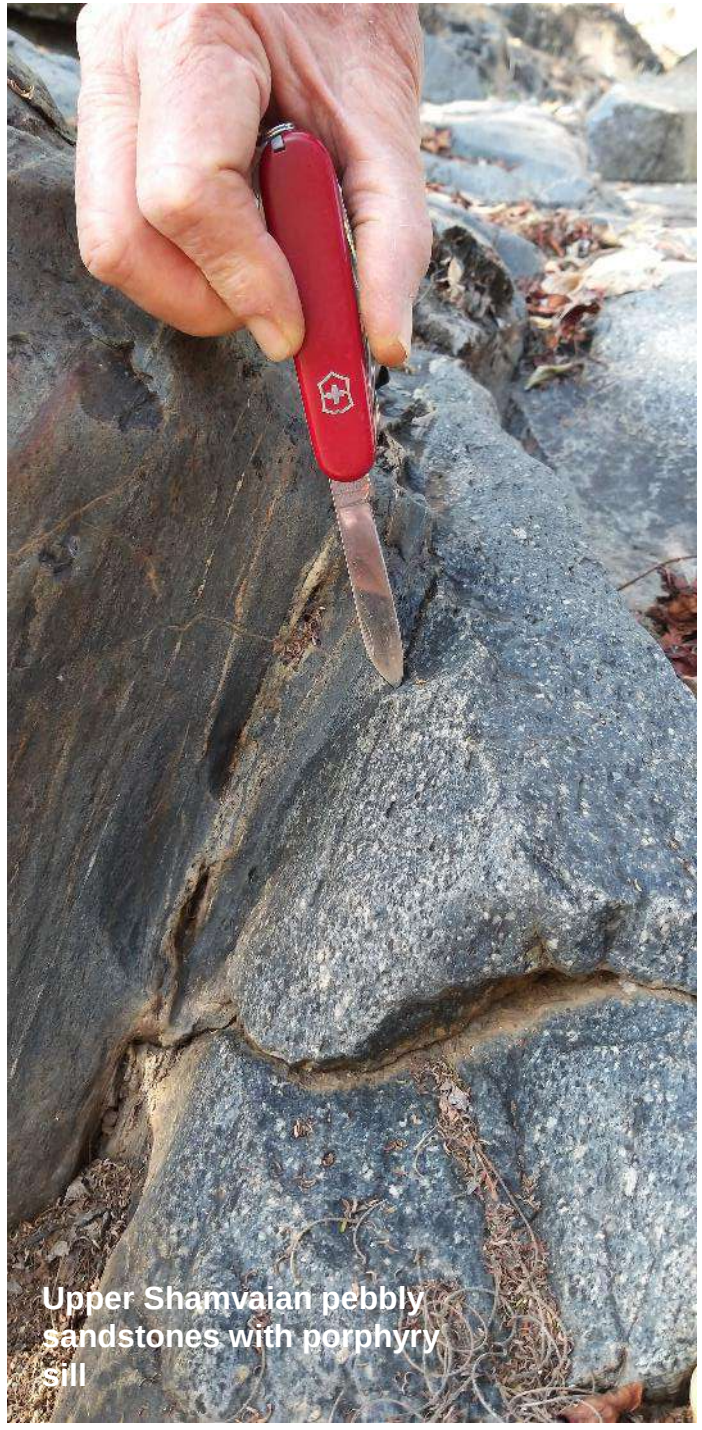


ZIM92/24 Hokonui Formation volcanic breccia



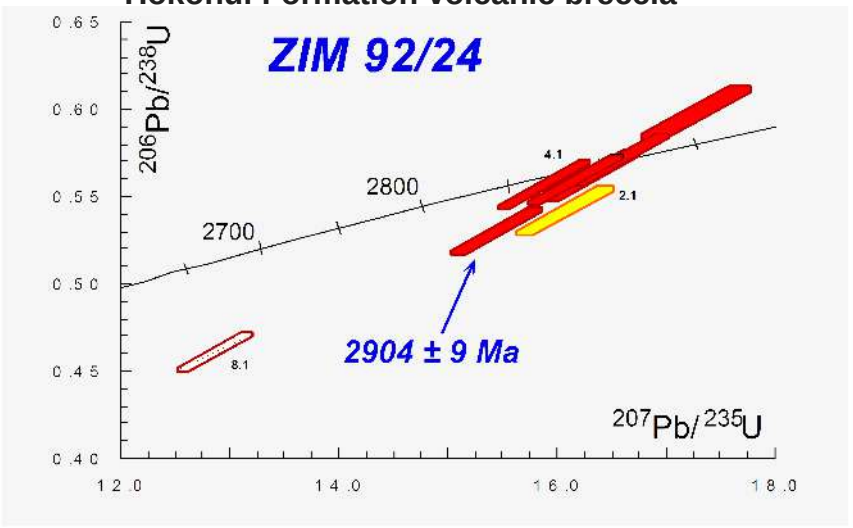
ZIM92/27: Lower Shamvaian vent breccia lapilli tuffs, Mutirikwe River

ZIM92/30: Maparu Formation porphyritic rhyolite

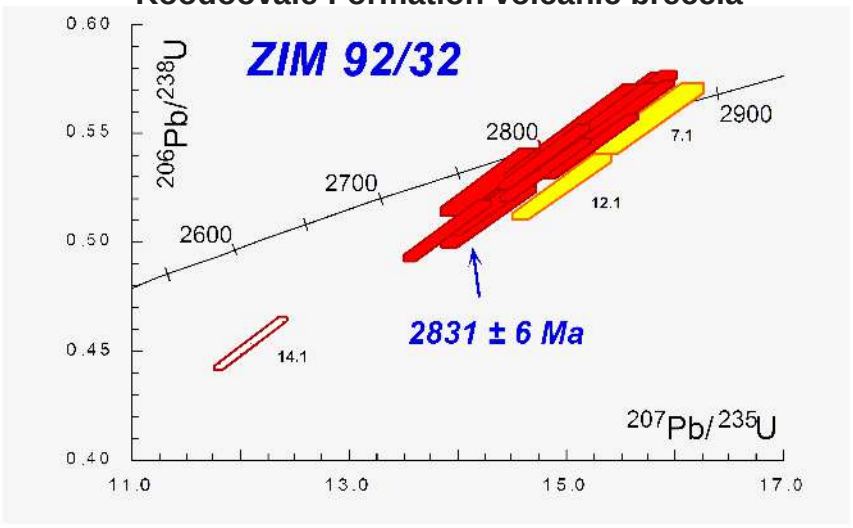


Upper Shamvaian pebbly sandstones with porphyry sill

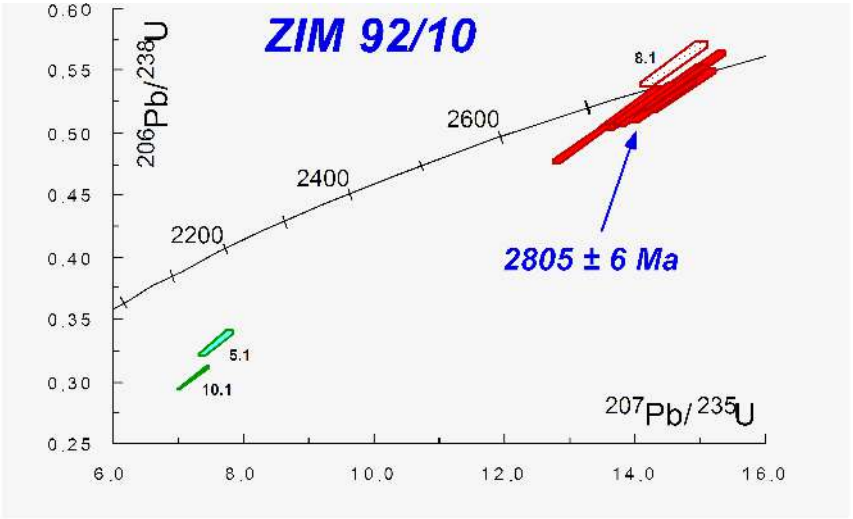
Hokonui Formation volcanic breccia



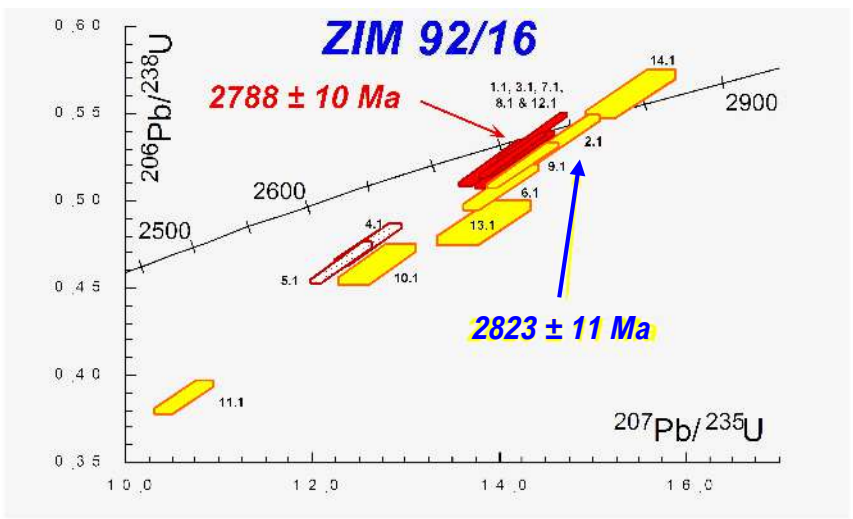
Koodoovale Formation volcanic breccia



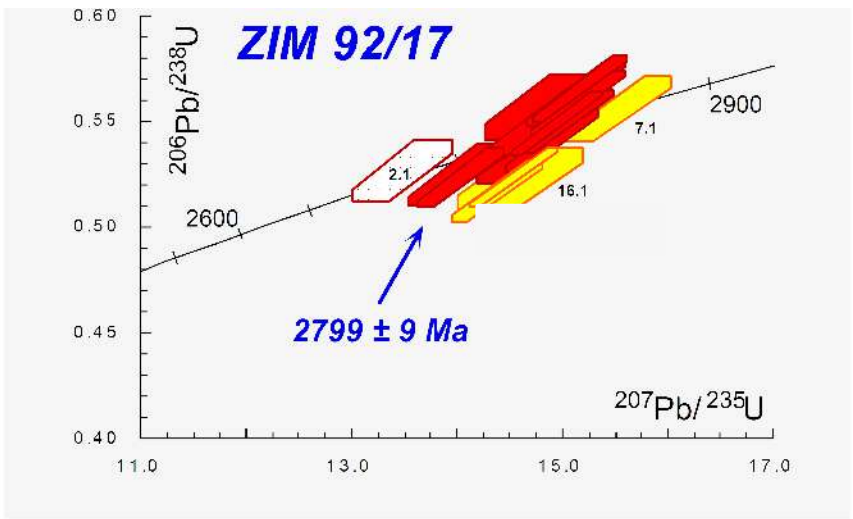
Arizona Formation dacite



Eldorado Formation foliated rhyolite

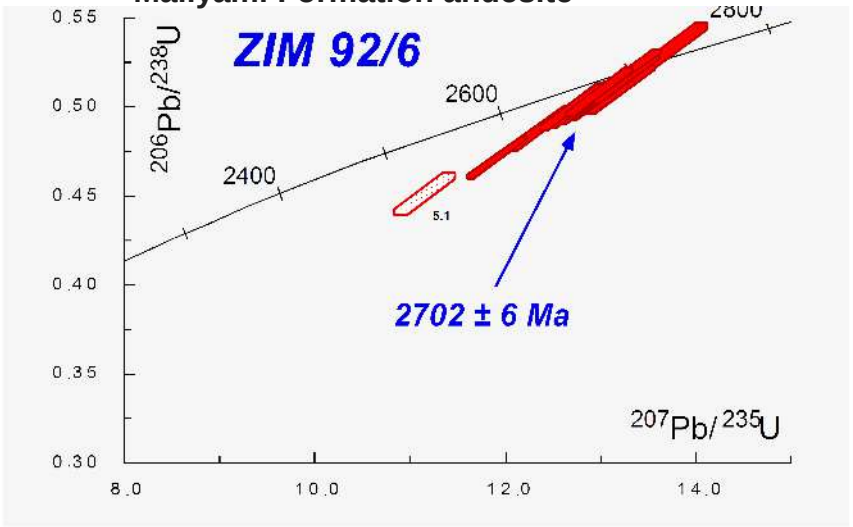


Eldorado Formation foliated rhyolite

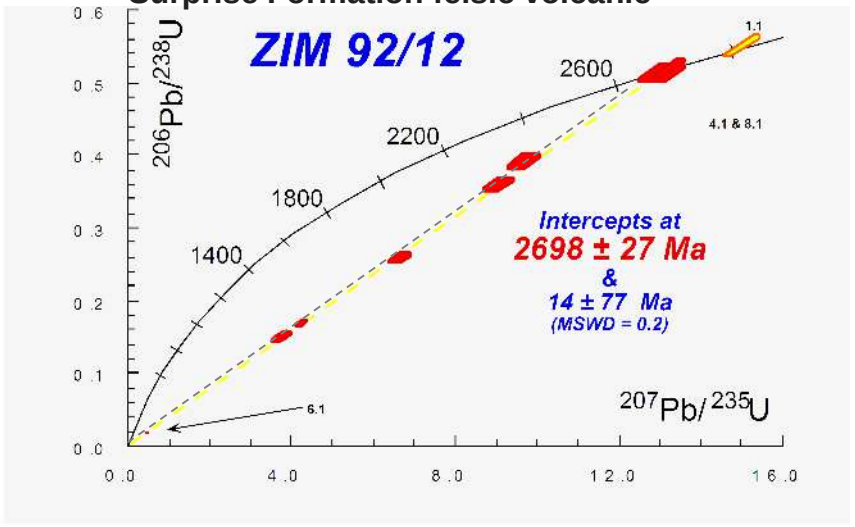


Concordia plots for five zircon populations taken from samples ZIM-74 (Iron Mask Formation), ZIM-60 (Wedza Suite gneiss), ZIM97-01 (Lower Shamvaian dacite tuff), ZIM-29 (Lower Shamvaian dacite porphyry), ZIM-79 (Mazowe granodiorite) and ZIM-80 (Bindura granodiorite). Note the presence of slightly older inherited zircons in ZIM92/32 (Koodoovale Formation), ZIM92/16 and ZIM92/16 (Eldorado Formation).

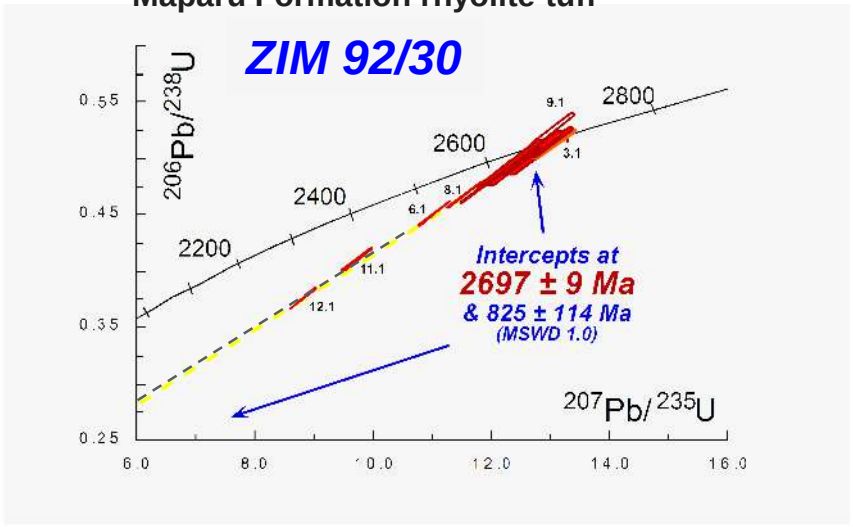
Maliyami Formation andesite



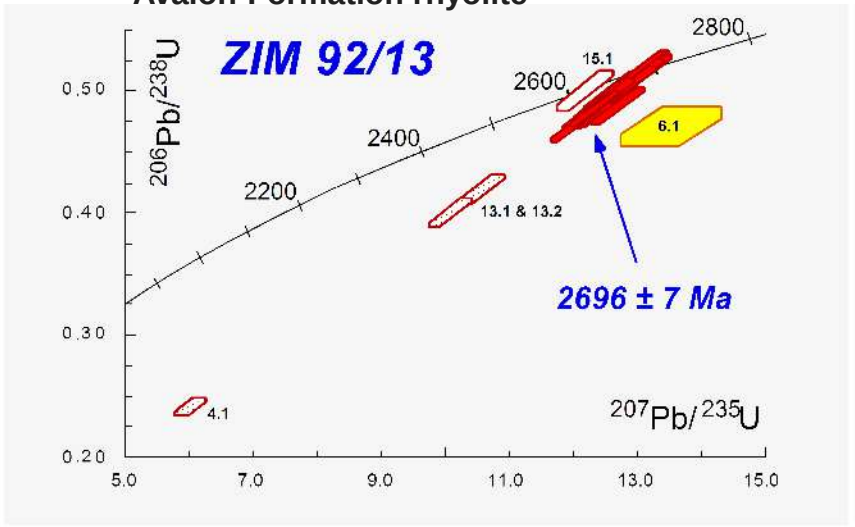
Surprise Formation felsic volcanic



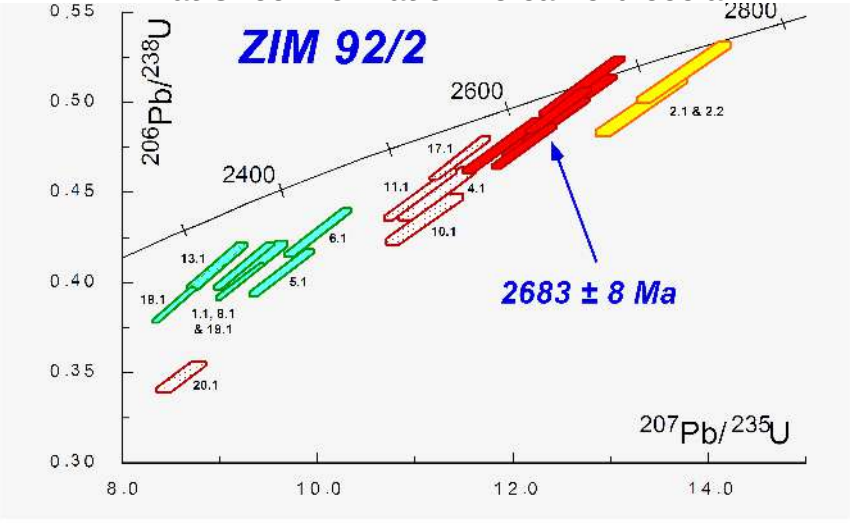
Maparu Formation rhyolite tuff



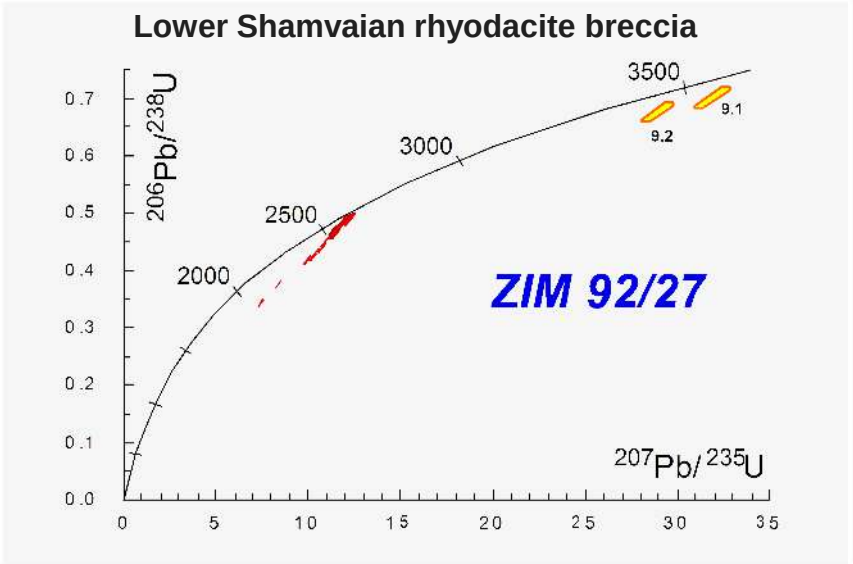
Avalon Formation rhyolite

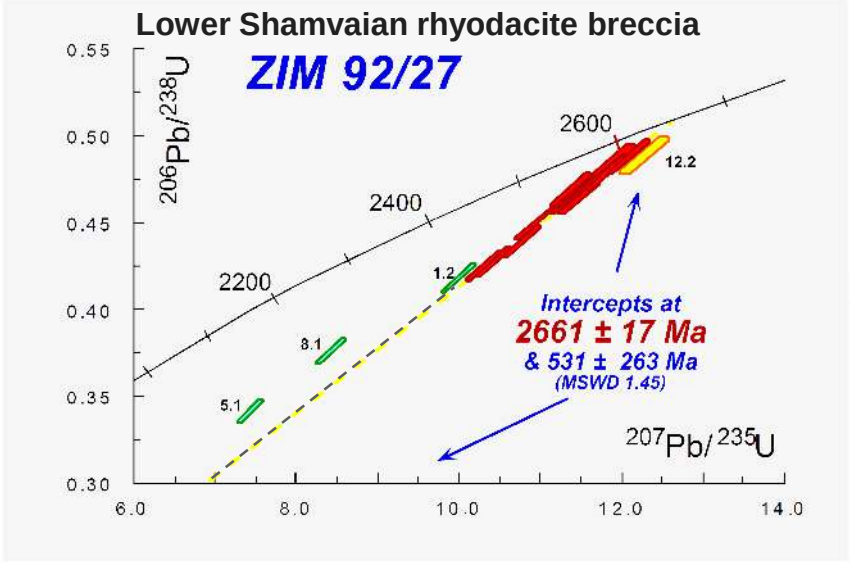


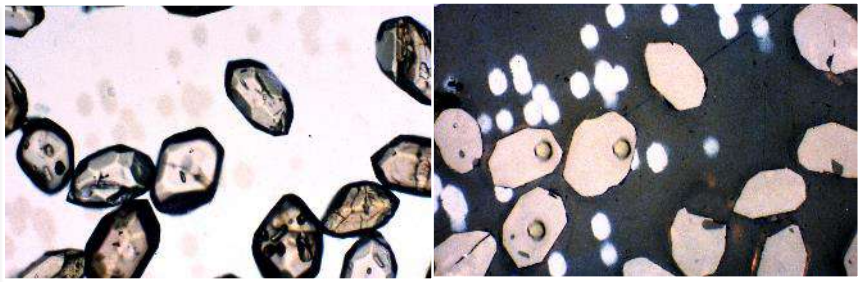
What Cheer Formation volcanic breccia



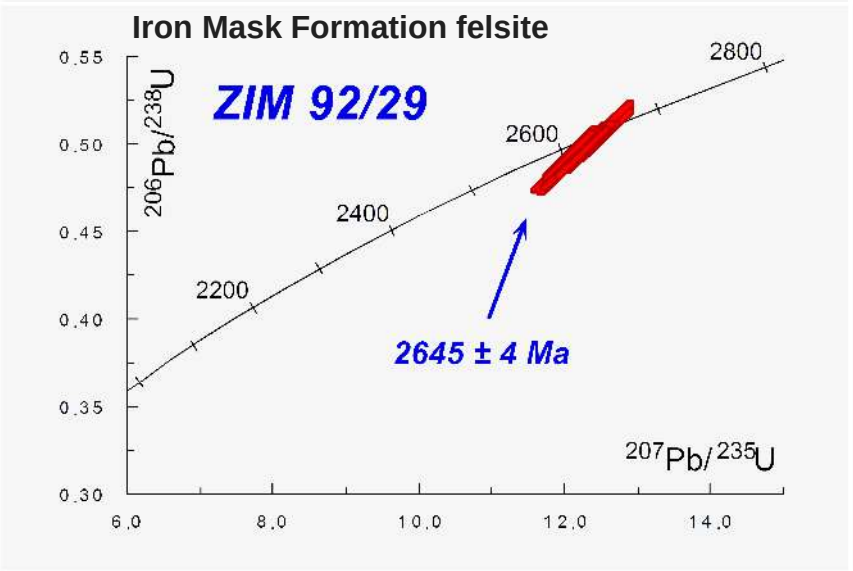
Concordia plots for five zircon populations taken from samples ZIM92/6 (Maliyami Formation), ZIM92/12 (Surprise Formation), ZIM92/30 Maparu Formation), ZIM92/13 (Avalon Formation) and ZIM92/2 (What Cheer Formation). Note the presence of ~2.8 Ga inherited zircons in the Surprise Formation, Avalon Formation and What Cheer Formation.

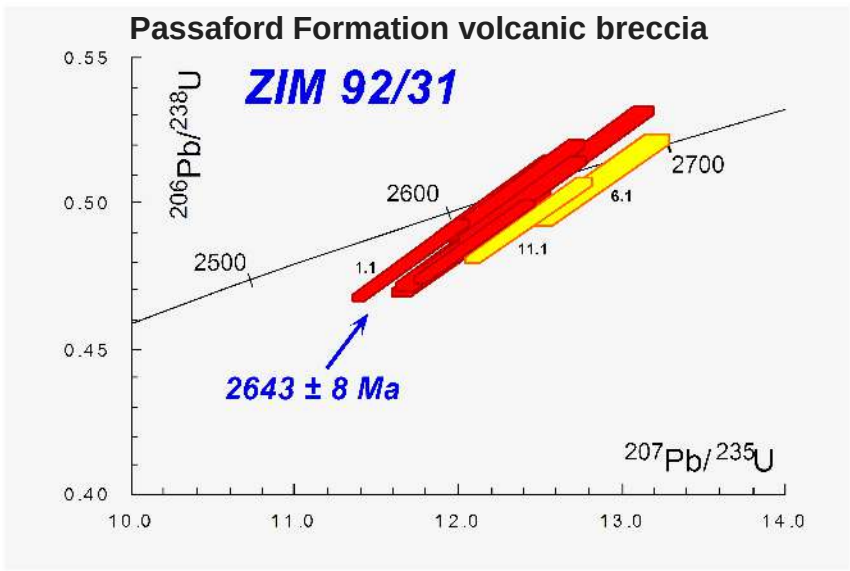




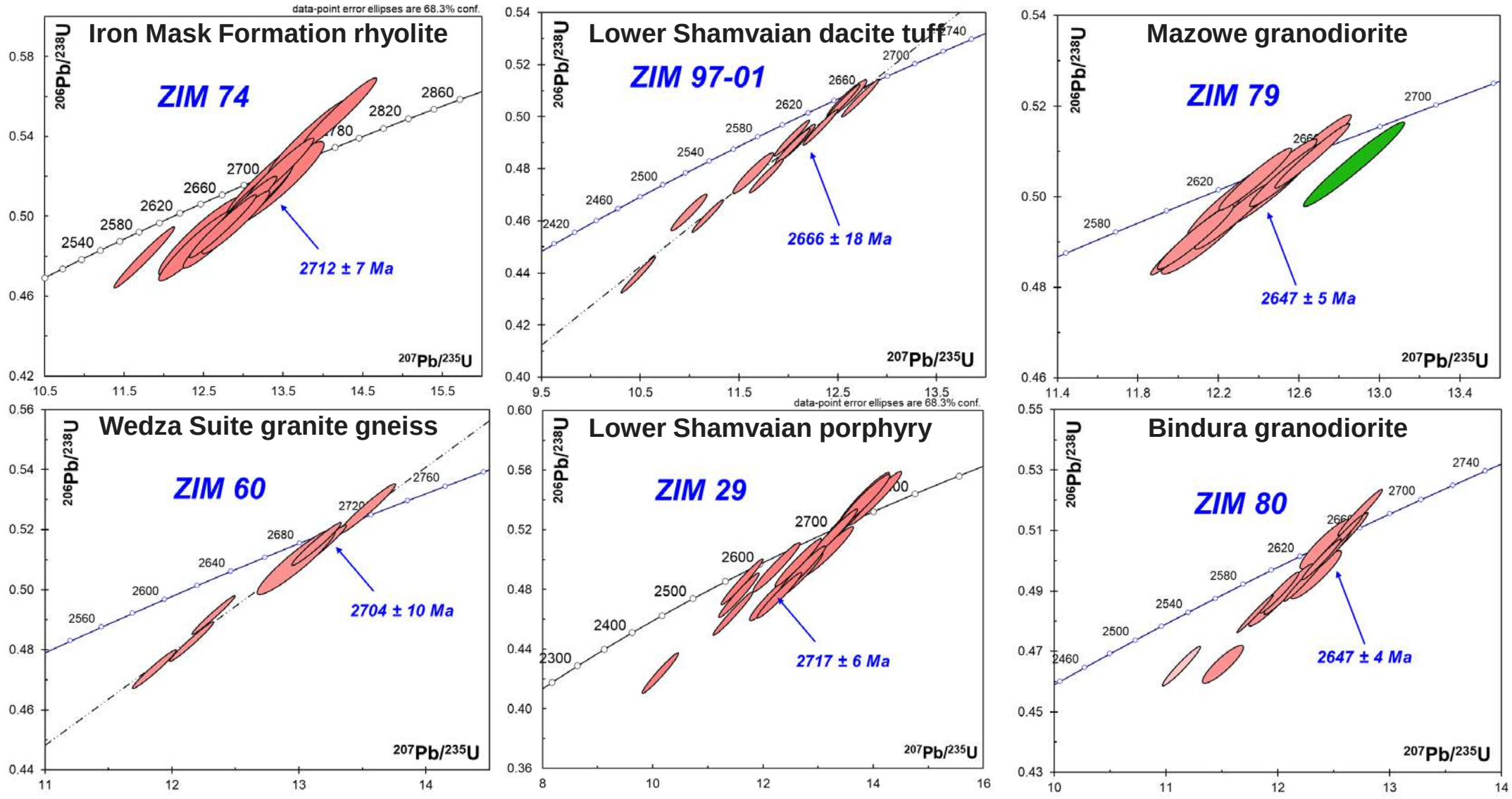


ZIM92/29 zircon morphology and BSE (back-scattered electron) image.





Concordia plots for three zircon populations taken from samples ZIM92/27 (Lower Shamvaian rhyodacite breccia from the Masvingo Belt), ZIM92/29 (Iron Mask Formation) and ZIM92/31 (Passaford Formation). Note the presence of c. 3.5 Ga inherited zircons in ZIM92/27.



Concordia plots for six zircon populations taken from samples ZIM-74 (Iron Mask Formation), ZIM-60 (Wedza Suite gneiss), ZIM97-01 (Lower Shamvaian dacite tuff), ZIM-29 (Lower Shamvaian dacite porphyry), ZIM-79 (Mazowe granodiorite) and ZIM-80 (Bindura granodiorite)

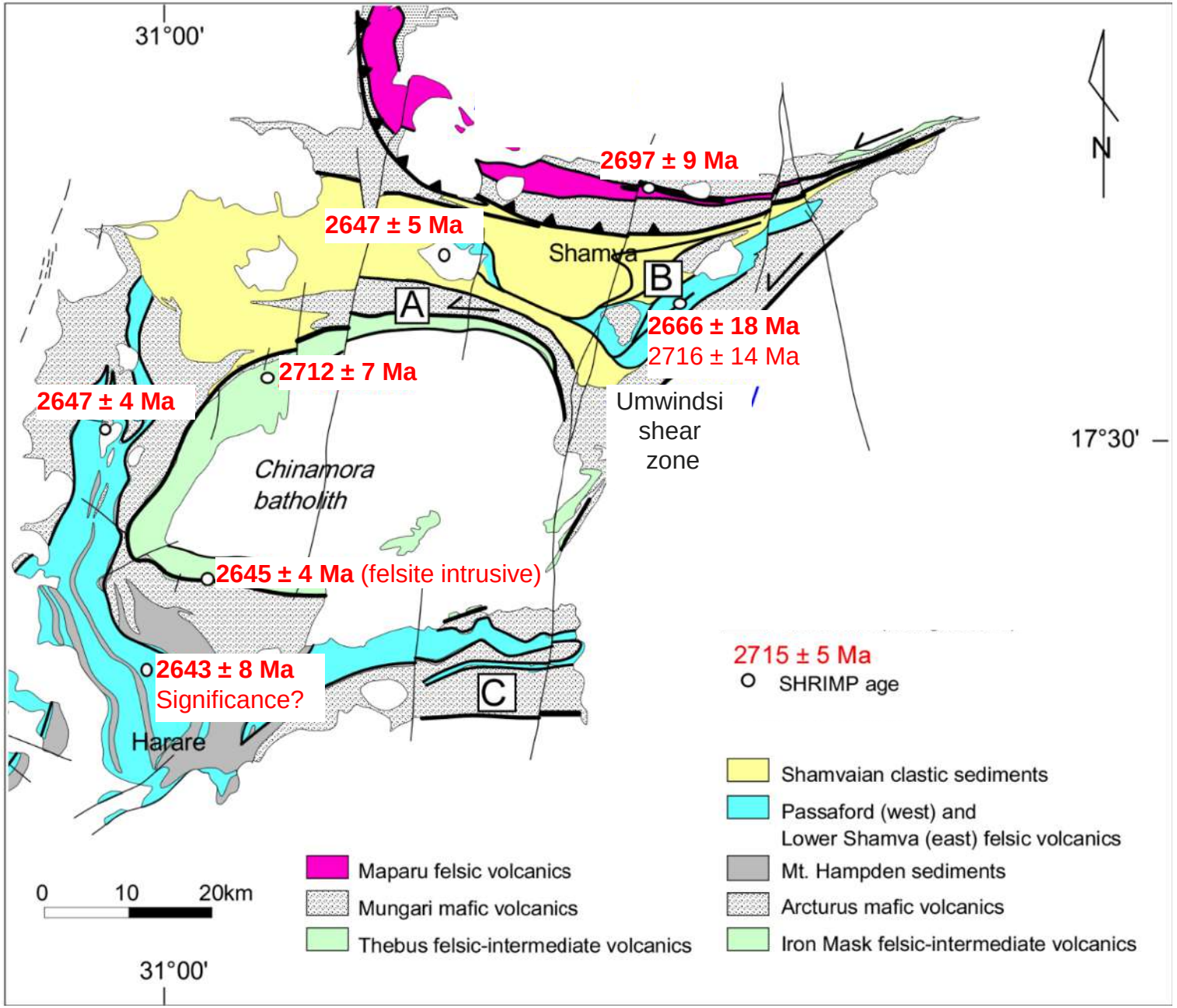
PROBLEMS

Geochronology

a) Sample ZIM92/29 of a banded felsite of the Iron Mask Formation yielded an age of 2645 ± 4 Ma which conflicts with the SHRIMP age of 2715 ± 4 Ma of zircons of sample ZIM-74. Three geological interpretations are possible:
   a) the zircons of sample ZIM92/29 are metamorphic;
   b) the rock is an intrusive felsite, possibly related to the late-tectonic magmatism that affected the Harare-Shamva greenstone belt, with the emplacement of multiphase stocks; this is the preferred interpretation and supported by zircon morphology and BSE imagery showing pyramidal edges, growth zoning and mineral inclusions; and is in agreement with Wilson et al. (1995) and Nisbett et al. (2000);
   c) the Iron Mask Formation, despite apparent continuity around the outer margin of the Chinamora batholith, is structurally more complex than recognized before and comprise two sequences that are different in age, but for which no evidence has been found.

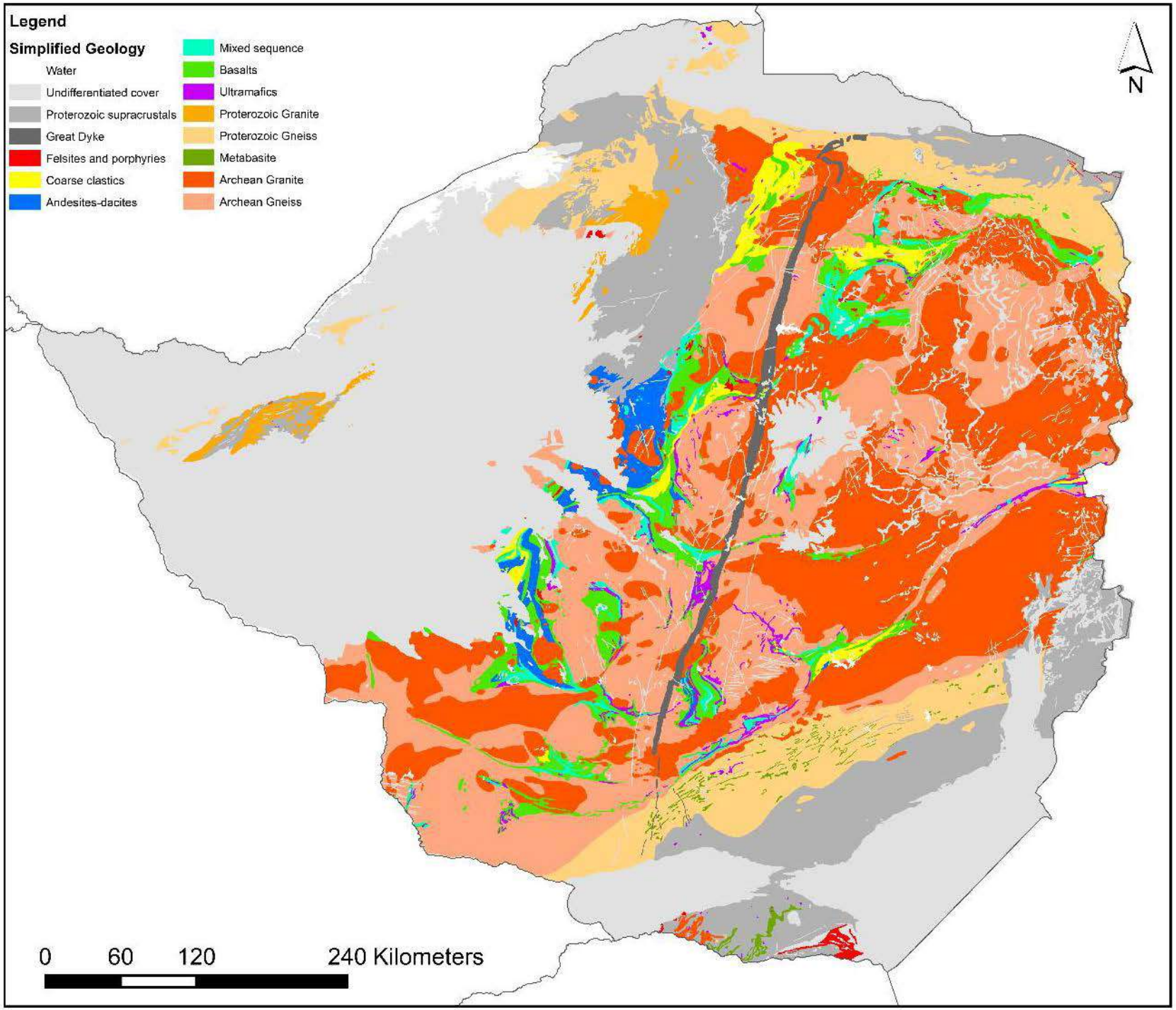
b) Sample ZIM92/31 of an andesite clast of a volcanic vent of the Passaford Formation yielded an age of 2643 ± 8 Ma. Field relations indicate that the Passaford Formation is the uppermost succession in the Harare greenstone belt and is intruded by the Mazowe granodiorite (ZIM-79), which yielded an age of 2647 Ma. These results are within error. Three geological interpretations are possible:
   a) the majority of the zircons of sample ZIM92/31 are metamorphic and the interpreted inherited zircons yielding an age of ~2683 Ma give the age of crystallization of the rock;
   b) the rock is a hypabyssal breccia unrelated to the Passaford Formation, and the extrusive equivalent of stocks such as Mazowe; this is the preferred interpretation;
   c) the Passaford Formation, comprising felsic volcanics, volcaniclastics, meta-arenites and meta-argillites (Baldock 1991) and as for the Shamvaian Supergroup, volcanism and sedimentation were contemporaneous.

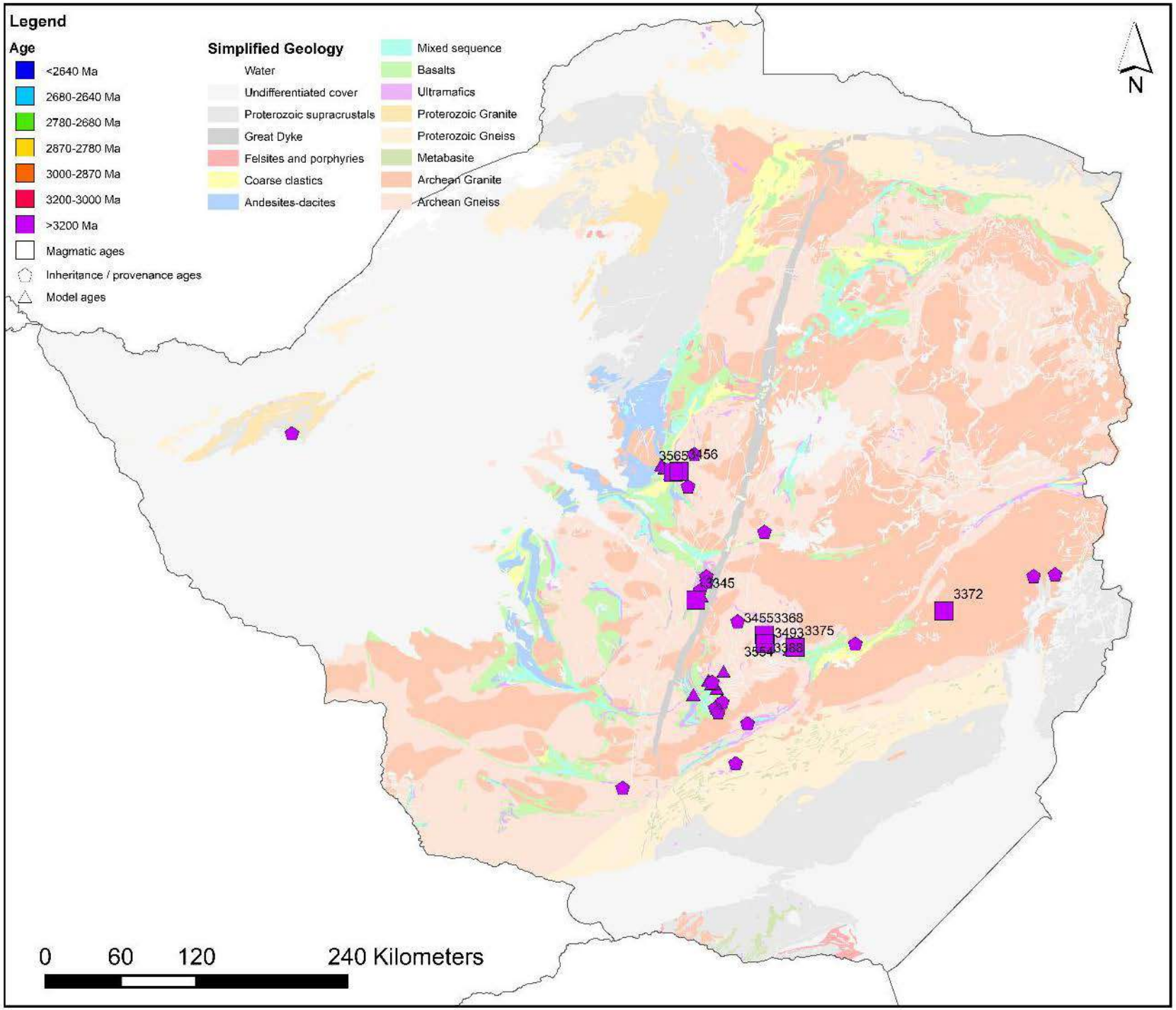
The rocks of the central part of the Harare greenstone belt, where sample ZIM92/31 was collected, although deformed, have only been metamorphosed at relatively low grade, greenschist to low amphibolite facies metamorphic conditions and the zircons are unlikely to be metamorphic. Options b and c are both plausible. Option (c) would mean that the Shamvaian Supergroup extends farther south than previously known but requires a short time window of <3 million years between volcanism, deformation and the emplacement of the late-tectonic Mazowe and Bindura stocks, both have yielded identical crystallization ages (2647 ± 5 Ma and 2647 ± 4 Ma).


31°00'
2697 ± 9 Ma
2647 ± 5 Ma
Shamva
B
A
2666 ± 18 Ma
2716 ± 14 Ma
2712 ± 7 Ma
2647 ± 4 Ma
Umwindsi
shear
zone
17°30'
Chinamora
batholith
2645 ± 4 Ma (felsite intrusive)
2643 ± 8 Ma
Significance?
C
Harare
N
2715 ± 5 Ma
SHRIMP age
Shamvaian clastic sediments
Passaford (west) and
Lower Shamva (east) felsic volcanics
Mt. Hampden sediments
Arcturus mafic volcanics
Iron Mask felsic-intermediate volcanics
Maparu felsic volcanics
Mungari mafic volcanics
Thebus felsic-intermediate volcanics
0 10 20km
31°00'

A TRIPARTITE SUBDIVISION?

Wilson et al. 1995			Geochronology	Intruded by:	Jelsma et al., 2020: West	Jelsma et al., 2020: East
Great Dyke			Great Dyke: 2574 ± 2 Ma East Dyke: 2574 ± 2 Ma Umvimeela (West) Dyke: 2577 ± 2 Ma		Great Dyke: 2574 ± 2 Ma East Dyke: 2574 ± 2 Ma Umvimeela (West) Dyke: 2577 ± 2 Ma	Great Dyke: 2574 ± 2 Ma East Dyke: 2574 ± 2 Ma Umvimeela (West) Dyke: 2577 ± 2 Ma
Shamvaian Supergroup	Upper Shamvaian Group		>2647 Ma	Bindura granodiorite: 2647 Ma	Upper Shamvaian Group	Upper Shamvaian Group
	Lower Shamvaian Group	Harare Sequence	Passaford Fm: 2643 ± 8 Ma	Chilimanzi Suite: 2620 Ma Glendale tonalite: 2618 Ma Mazowe granodiorite: 2647 Ma	Lower Shamvaian Group	Lower Shamvaian Group
		H marker				
		U6 ?	Lake Kyle vent: 2661:Ma Porphyries: 2666-2661 Ma			
Bulawayan Supergroup	Upper Bulawayan Group	U5	Maliyami Fm: 2702 Ma	Sesombi tonalite: 2672 Ma	U4W: Bimodal Fm: 2700-2680 Ma Avalon, Maparu, What Cheer, Maliyami Iron Mask Fm: 2712 Ma	U4E: 2700-2680 Ma Cheshire Fm Zeederbergs Fm: 2698 Ma
		U4W/U4E	What Cheer Fm: 2683 Ma Avalon Fm: 2696 Ma Maparu Fm: 2697 Ma	Mashaba-Chibi dykes: 2700 Ma		
		U3	Surprise Fm: 2698 Ma Zeederbergs Fm			
		U2	Reliance Fm: 2745 Ma Sills: 2740-2733 Ma (Phurombuzi, Shangani)			Reliance Fm: 2745 Ma
		U1	Iron Mask Formation: 2712 Ma Manjeri Formation: >2745 Ma	Wedza gneiss: 2704 Ma Mutare tonalite: 2741 Ma		Manjeri Fm: >2745 Ma
	M marker					M marker
	Lower Bulawayan Group	L4	Koodoovale Fm: 2803-2788 Ma Arizona Fm: 2805 Ma Eldorado Fm: 2799-2788 Ma	Somabula tonalite: 2752 Ma Gwenoro Dam gneiss: 2769 Ma		Koodoovale Fm
K marker						K marker
Belingwean Supergroup	Upper Belingwean Group	L3	Brooklands Fm Buchwa quartzite			Bend Fm
	B marker					B marker
	Lower Belingwean Group	L2	Mafic Fm: 2880-2870 Ma Redcliff Jaspillite Formation: 2870 Ma Hokonui Fm: 2904 Ma	Chingezi Suite: 2850-2837 Ma Ngezi tonalite: 2875 Ma		Mafic Fm: 2880-2870 Ma Redcliff Jaspillite Formation: 2870 Ma Hokonui Fm: 2904 Ma
		L1	Manica felsic volcanics: 2990 Ma	Rhodesdale gneiss: 2946 Ma		Manica felsic volcanics: 2990 Ma
Sebakwian Group			> 3375 Ma Shabani Gneiss: 3475 Ma Tokwe Gneiss: 3554 Ma Sebakwe River Gneiss: 3565 Ma	Mont d'Or granite: 3350 Ma Mushandike Granite: 3375 Ma		> 3375 Ma Shabani Gneiss: 3475 Ma Tokwe Gneiss: 3554 Ma Sebakwe River Gneiss: 3565 Ma


Legend
Simplified Geology
Water
Undifferentiated cover
Proterozoic supracrustals
Great Dyke
Felsites and porphyries
Coarse clastics
Andesites-dacites
Mixed sequence
Basalts
Ultramafics
Proterozoic Granite
Proterozoic Gneiss
Metabasite
Archean Granite
Archean Gneiss
N
0
60
120
240 Kilometers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2870-2780 Ma
3000-2870 Ma
3200-3000 Ma
>3200 Ma
Magmatic ages
Inheritance / provenance ages
Model ages
Simplified Geology
Water
Undifferentiated cover
Proterozoic supracrustals
Great Dyke
Felsites and porphyries
Coarse clastics
Andesites-dacites
Mixed sequence
Basalts
Ultramafics
Proterozoic Granite
Proterozoic Gneiss
Metabasite
Archean Granite
Archean Gneiss
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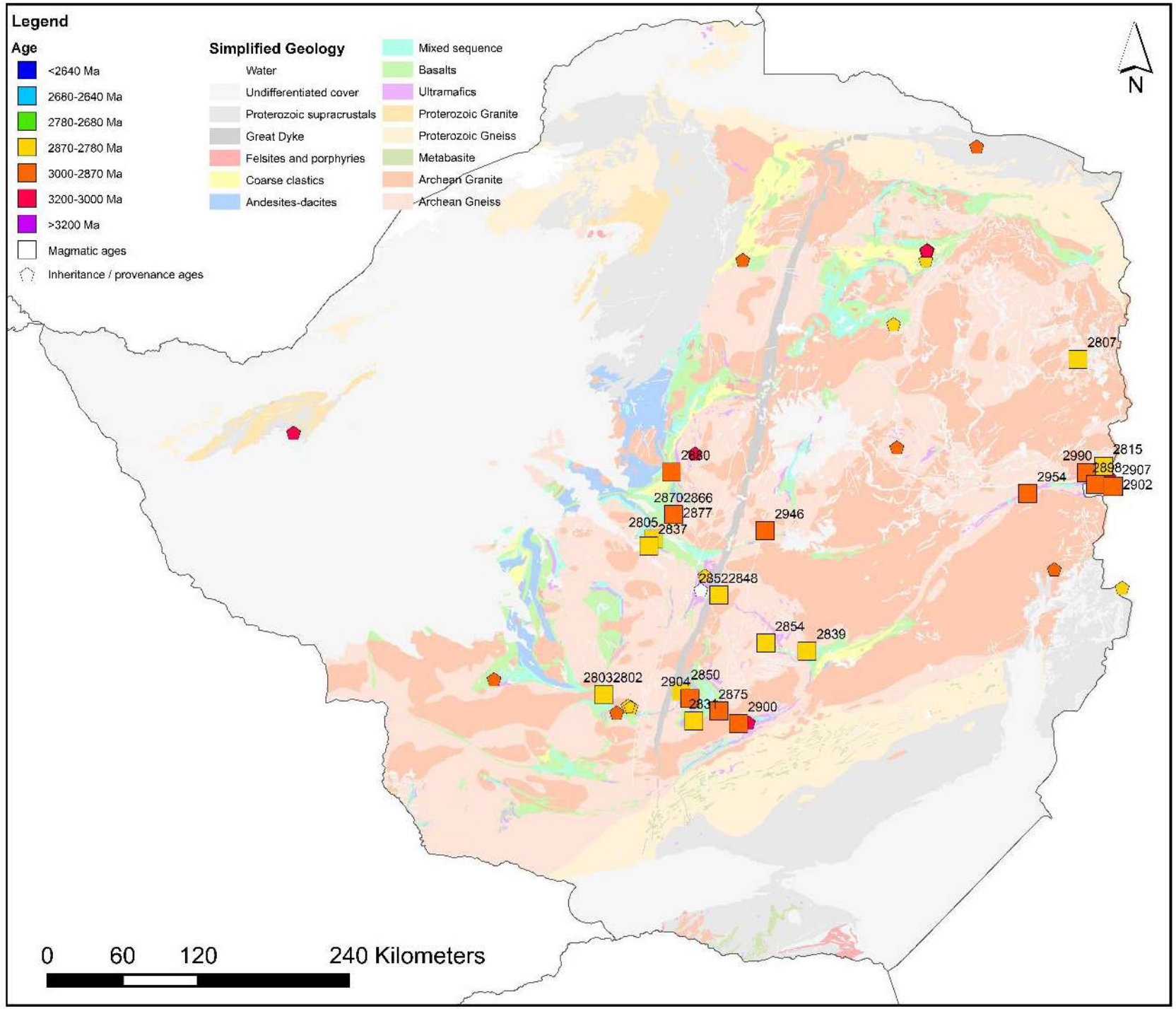
3372
0 60 120 240 Kilometers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Basalts
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Proterozoic Granite
Proterozoic Gneiss
Metabasite
Archean Granite
Archean Gneiss
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28702866
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120
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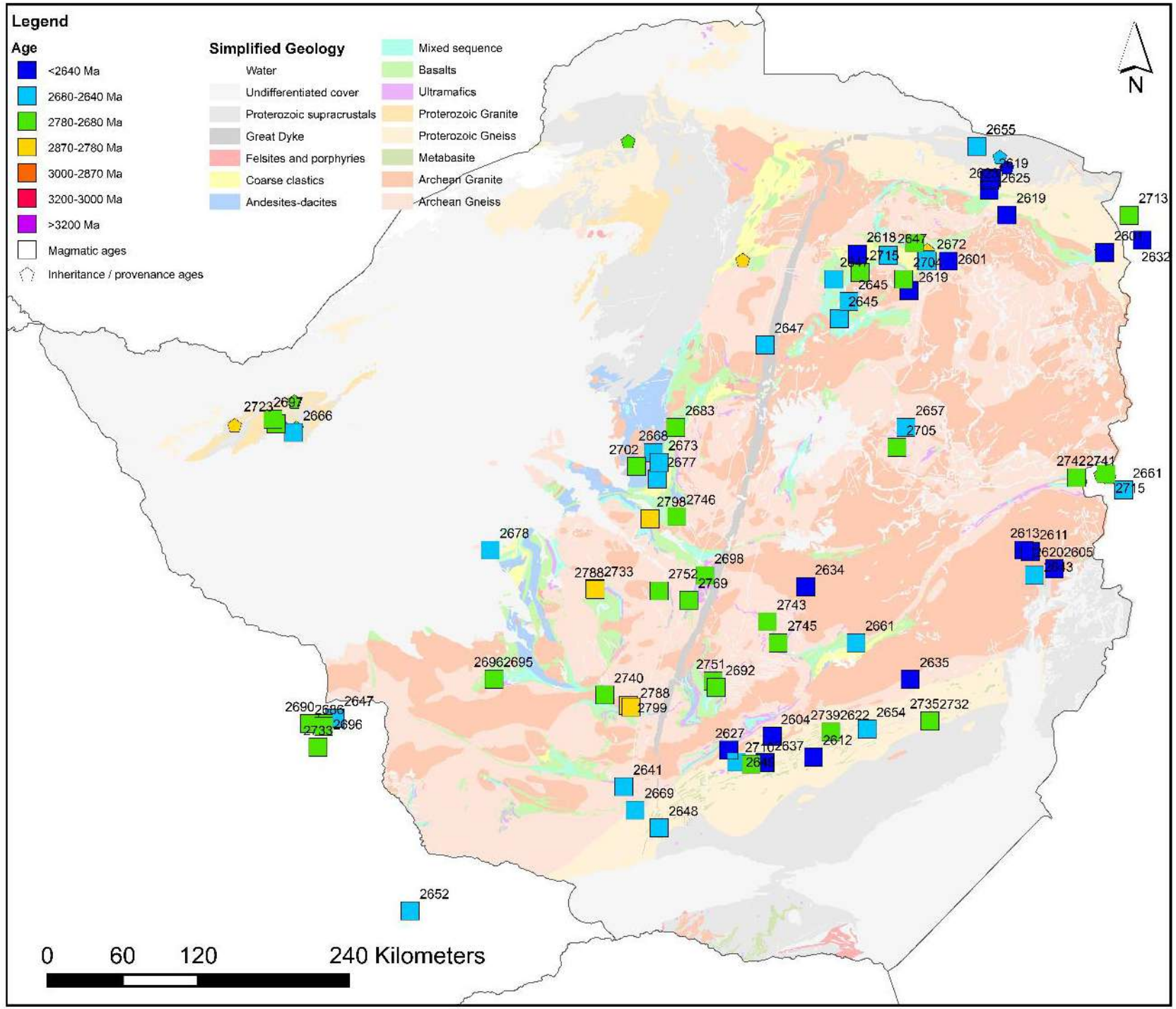
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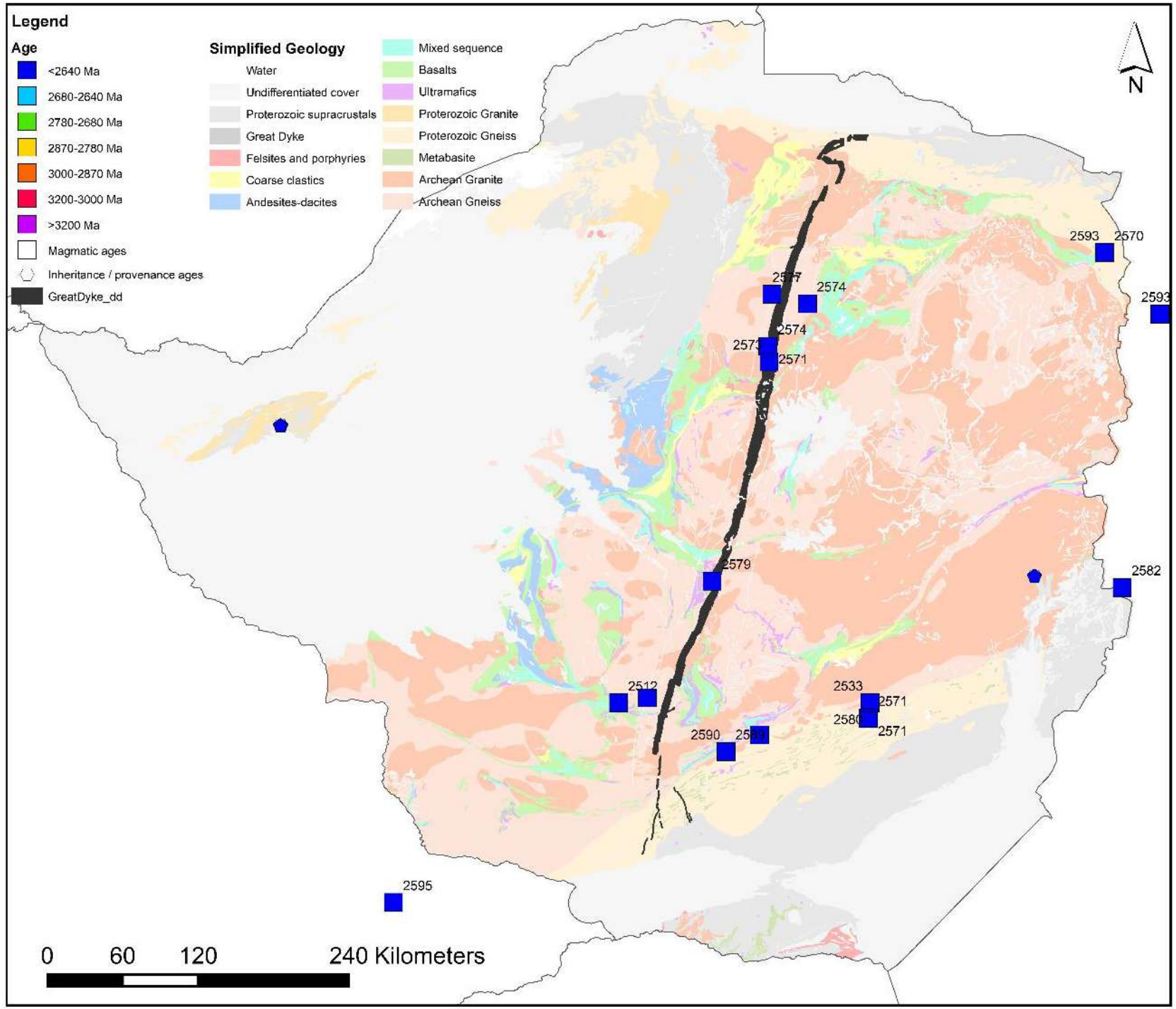
Basalts
Ultramafics
Proterozoic Granite
Proterozoic Gneiss
Metabasite
Archean Granite
Archean Gneiss
N
0 60 120 240 Kilometers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Age
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2870-2780 Ma
3000-2870 Ma
3200-3000 Ma
>3200 Ma
Magmatic ages
Inheritance / provenance ages
GreatDyke_dd
Simplified Geology
Water
Undifferentiated cover
Proterozoic supracrustals
Great Dyke
Felsites and porphyries
Coarse clastics
Andesites-dacites
Mixed sequence
Basalts
Ultramafics
Proterozoic Granite
Proterozoic Gneiss
Metabasite
Archean Granite
Archean Gneiss
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2593
2570
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2595
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60
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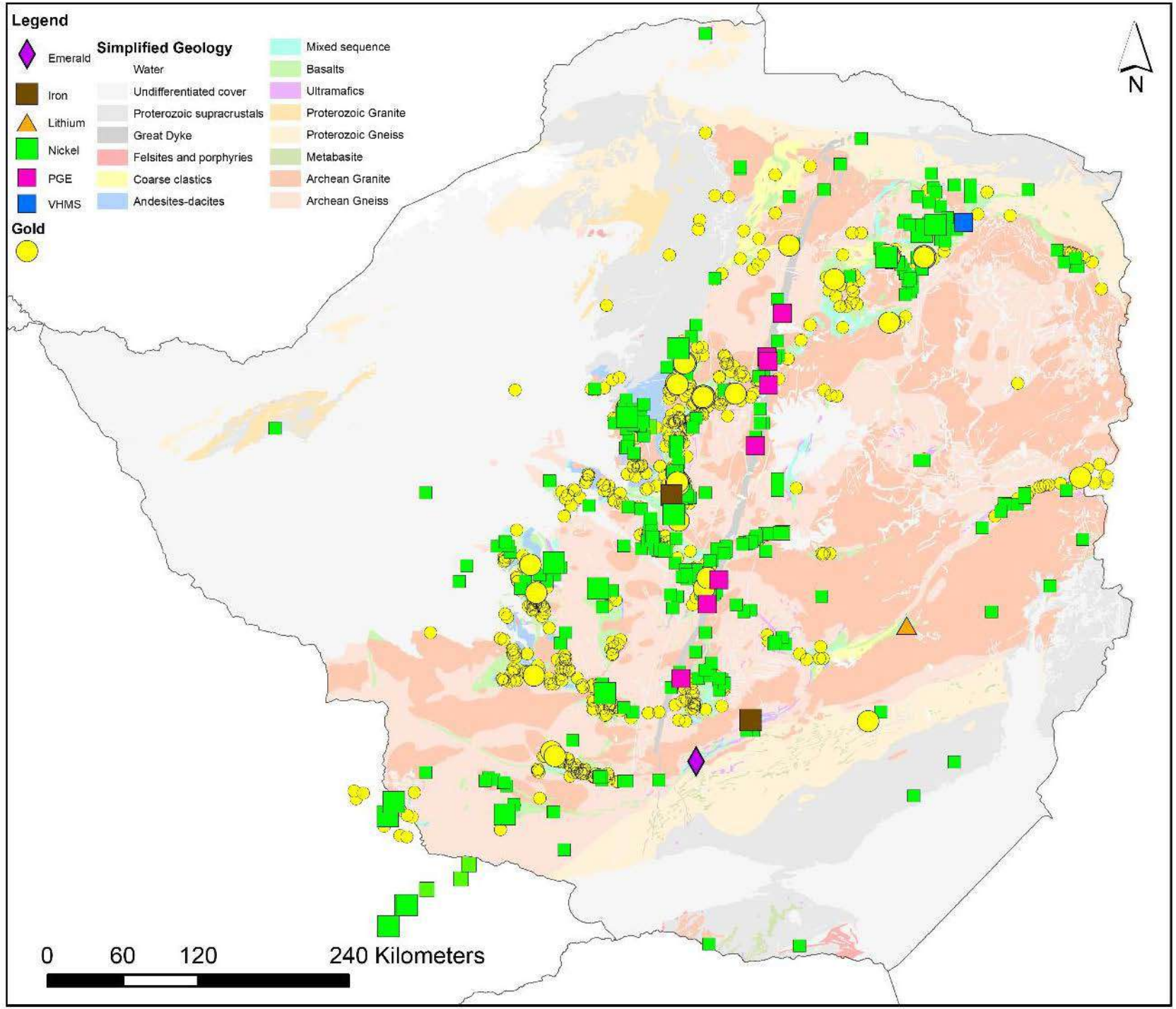
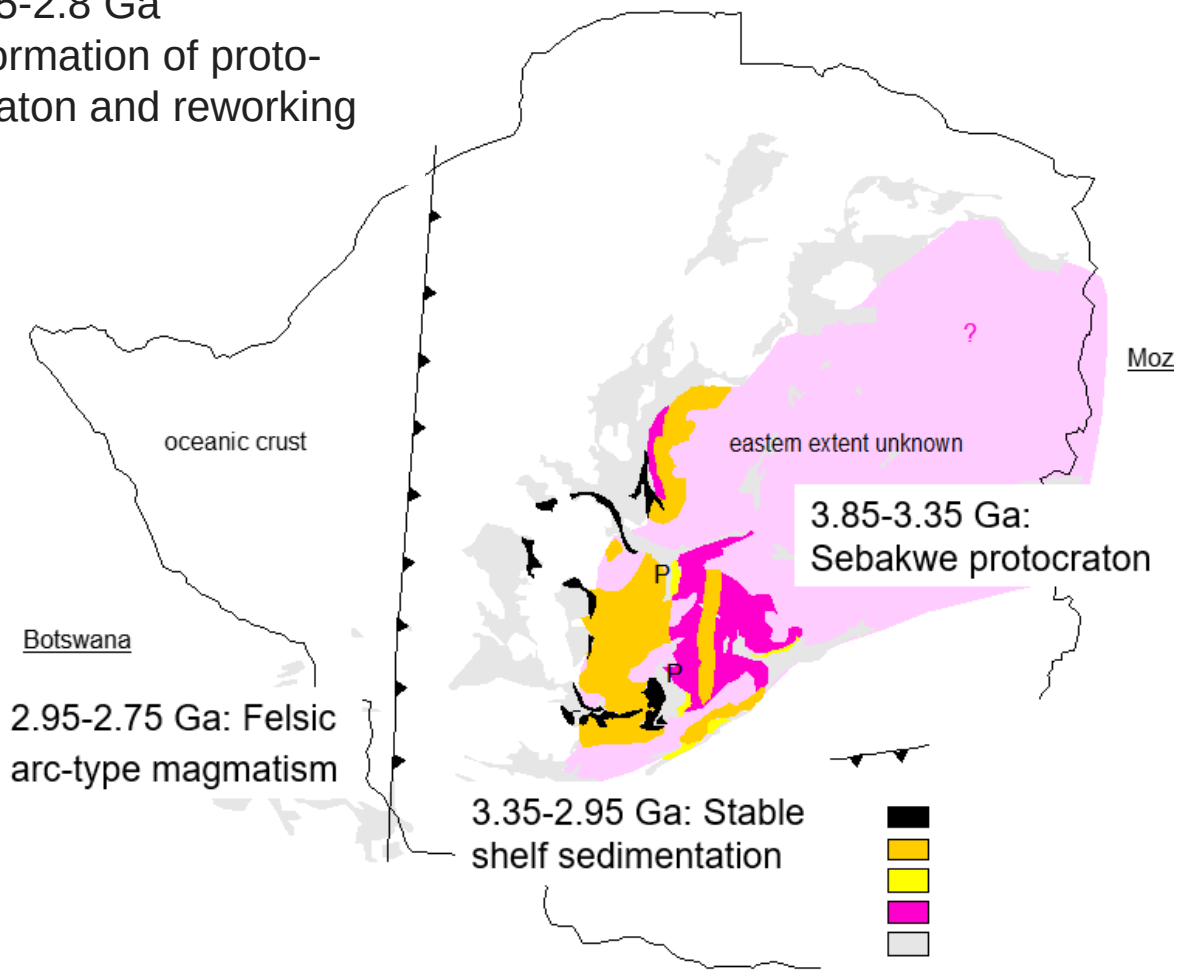
240 Kilometers


Legend
Emerald
Iron
Lithium
Nickel
PGE
VHMS
Gold
Simplified Geology
Water
Undifferentiated cover
Proterozoic supracrustals
Great Dyke
Felsites and porphyries
Coarse clastics
Andesites-dacites
Mixed sequence
Basalts
Ultramafics
Proterozoic Granite
Proterozoic Gneiss
Metabasite
Archean Granite
Archean Gneiss
N
0
60
120
240 Kilometers

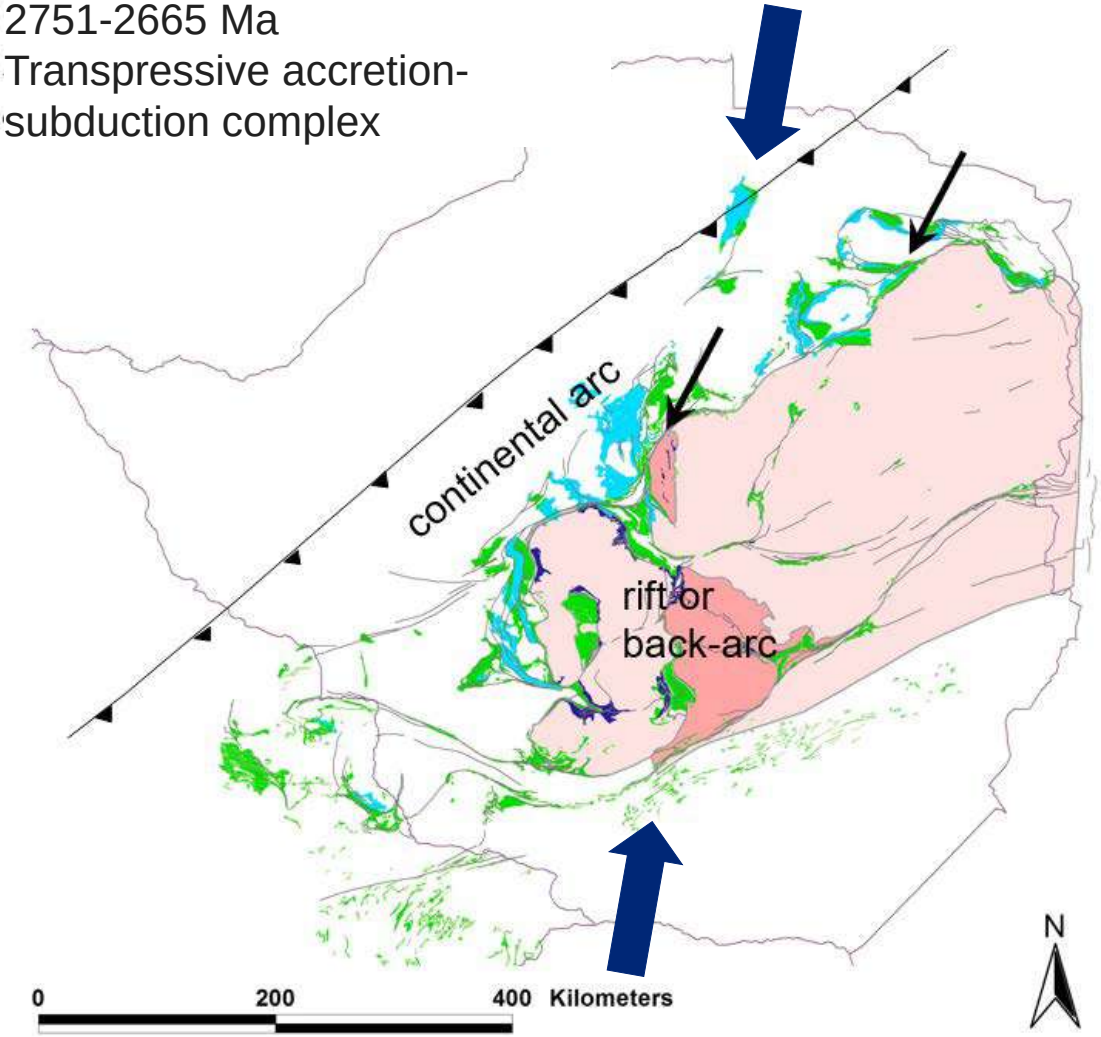
3.5-2.8 Ga
Formation of proto-craton and reworking



modified after Jelsma and Dirks 2002

(2) >800 km long NE-SW arc:
Calcalkaline (predominantly basaltic-rhyolitic) magmatism constrained between 2712-2647 Ma, including several generations of porphyries

2751-2665 Ma
Transpressive accretion-subduction complex



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

DISCUSSION

Geochronology

Wilson-Nesbitt-Fanning phase:

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

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

- ZIM74, Iron Mask Formation: TIMS 2715 ± 15 Ma and SHRIMP 2712 ± 7 Ma
- ZIM60, Wedza Suite gneiss, edge of Chinamora batholith: TIMS 2667 ± 4 Ma, SHRIMP 2704 ± 10 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 ± 18 Ma
- ZIM79, Mazowe granodiorite cuts Passaford Formation: TIMS 2664 ± 15 Ma, SHRIMP 2647 ± 5 Ma
- ZIM80, Bindura granodiorite cuts Upper Shamvaian: TIMS 2649 ± 6 Ma, SHRIMP 2647 ± 4 Ma

Unconformity of almost 20 years... (2000-2019)

Jelsma-Nesbitt-Fanning phase:

- Western Succession 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 (Bagai, 2000; Bagai et al., 2002).
- Wedza Suite may have been cogenetic with Iron Mask Formation and Maparu Formation.
- Bimodal volcanism was followed by onset of accretion and deposition of Shamvaian basin sediments, accompanied by felsic volcanism.
- 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.
- And the Great Dyke at 2575 Ma

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.
- There is a clear need for new isotope studies (terranechron mapping) and high precision geochronology, including using baddeleyite.
- There are marked differences between the Upper Bulawayan Eastern and Western Successions (Wilson 1979), probably indicative of fundamentally different geodynamic environments of deposition.
- Bimodal magmatism and increased abundance of intermediate and felsic magmatism within the Western Succession, with relatively unevolved isotope systematics, is reminiscent of magmatic arc settings, earlier suggested by for instance Condie and Harrison (1976), Nisbet et al. (1981) and Jelsma and Dirks (2002).
- Magmatism within the Eastern Succession, with geochemical signatures suggesting contamination and inputs from Paleoarchean and Mesoarchean crust, is probably reminiscent of rift or Red Sea-type settings. Rifting may have been triggered by the Reliance Formation event.
- The presence of unconformities such as Koodoovale and Manjeri are important time markers within *parts* of the craton; the stratigraphic significance of the contact between the Kwekwe Felsitic Formation and the Redcliff Jaspillite Formation (Prendergast and Wingate, 2013) needs to be better understood.

CONCLUDING REMARKS

- An association of komatiites and feeder systems of the Reliance Formation of the Eastern Succession and nickel mineralization, and of the Western Succession and polymetallic Ni-Cu (± PGE) mineralization appears apparent.
- An intimate association with Shamvaian felsic volcanism and sedimentation in the Shamva belt; the latter showing a polymict clast assemblage showing significant inputs from older continental crust; the same appears to occur in the Harare belt.
- the emplacement of juvenile multiphase plutons and porphyry stocks with associated Au or Au-Mo mineralization (Campbell and Pitfield, 1994; Vinyu et al., 1996) is now well constrained with the new age results for the Mazowe and Bindura plutons at 2647 Ma, providing an upper age limit to the timespan of Shamvaian deposition.

AngloAmerican

THANK YOU