Basement architecture of the Central African Shield

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Focused on future-enabling metals & minerals: copper, nickel and PGMs

Leading Mineral Systems Science

District-scale positions in compelling search space

Portfolio diversification

Investor presentation, 11 Dec 2021

Global mining and/or exploration presence, in South Africa, Zimbabwe, Botswana, Namibia, Angola and Zambia, United Kingdom, Australia, Canada and Greenland, Brazil, Peru, Chile and Ecuador

Diversified commodities: Iron ore and manganese, metallurgical coal, copper, nickel, platinum group metals, diamonds, fertilizers

Overview

- Context
- Architecture of two Cratons
- Terrain
- Geochronology
- Discussion and Conclusions

Context of Study

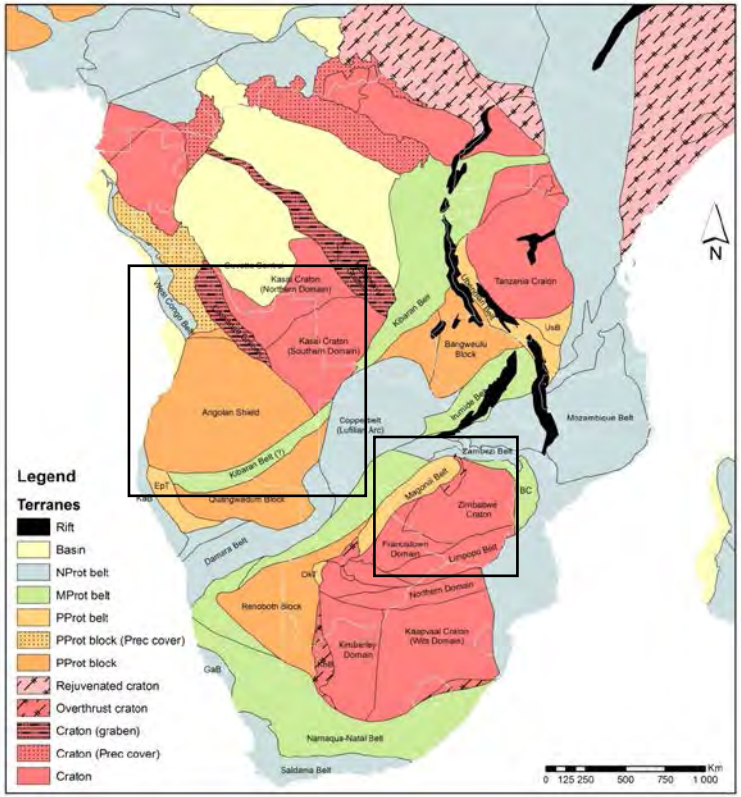
- Objective

  To gain new insights into the architecture and tectonic and temporal evolution of Central Africa, to support new project generation

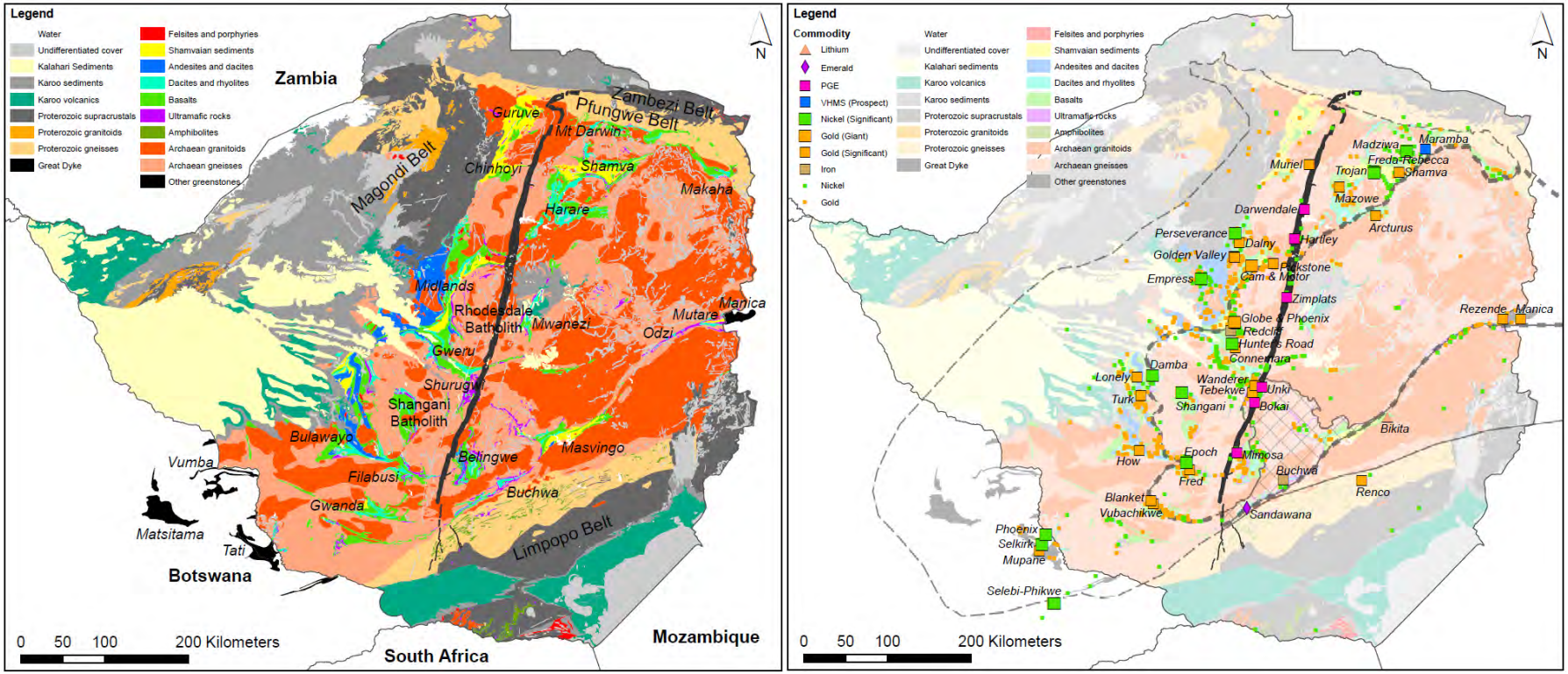
- Rationale
  - Basement architecture poorly constrained, due to lack of geoscience data
  - Geology mainly limited to investigations during colonial times
  - Radiometric data scarce, comprising largely pre-1990's ages, no longer considered reliable
  - This has started to improve, with the release of new PLANAGEO data for Angola through IGEO

- Scope
  - Southwestern part of the Central African Craton in Angola and DRC
  - Area extent of >2 million km^2, much of which is covered by Phanerozoic sediments

Architecture of Southern and Central Africa

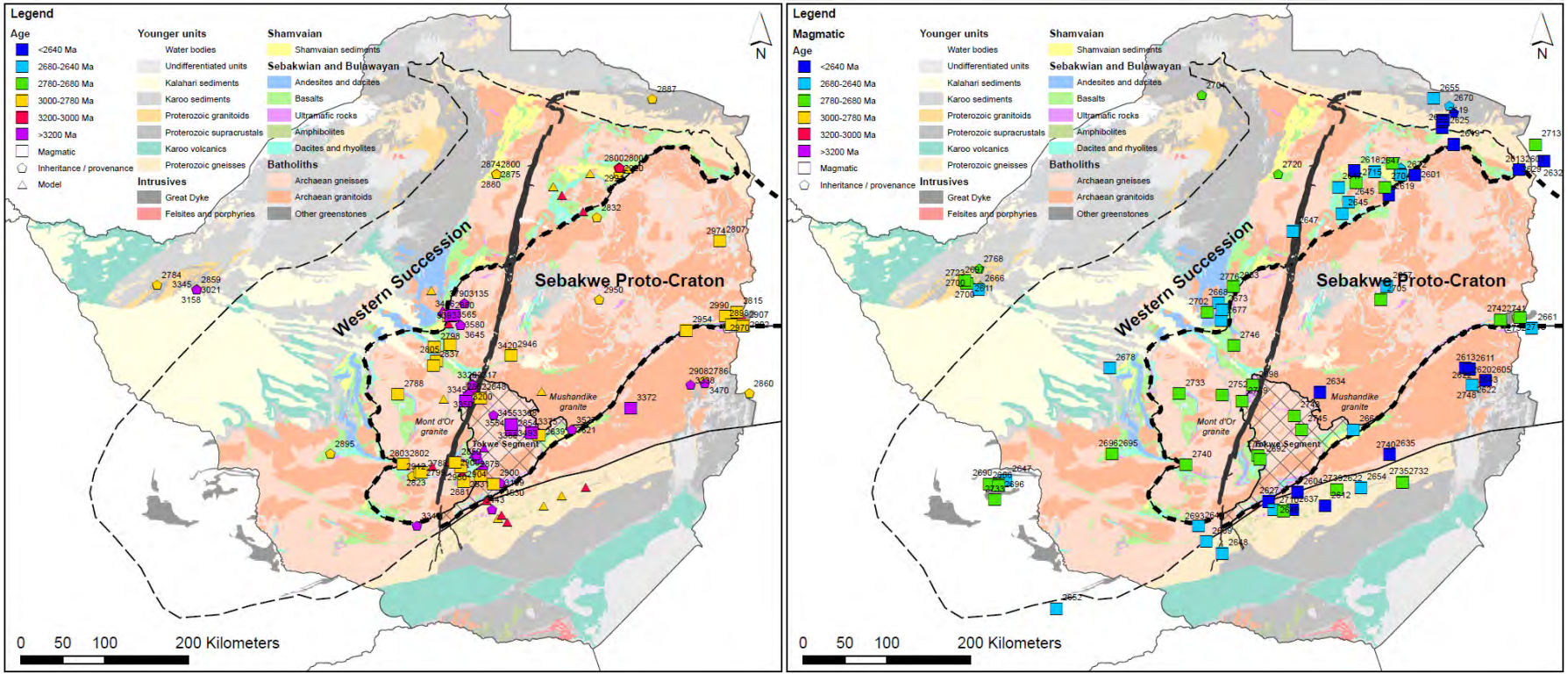


Zimbabwe Geology



Jelsma et al. 2021 and references therein

Craton Architecture and Geochronology



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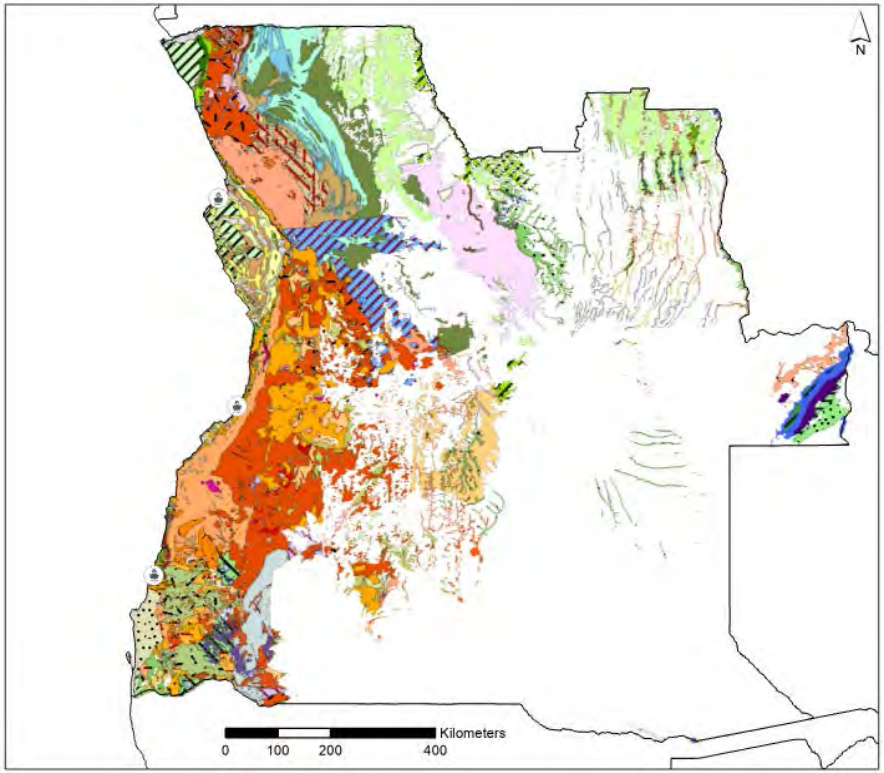
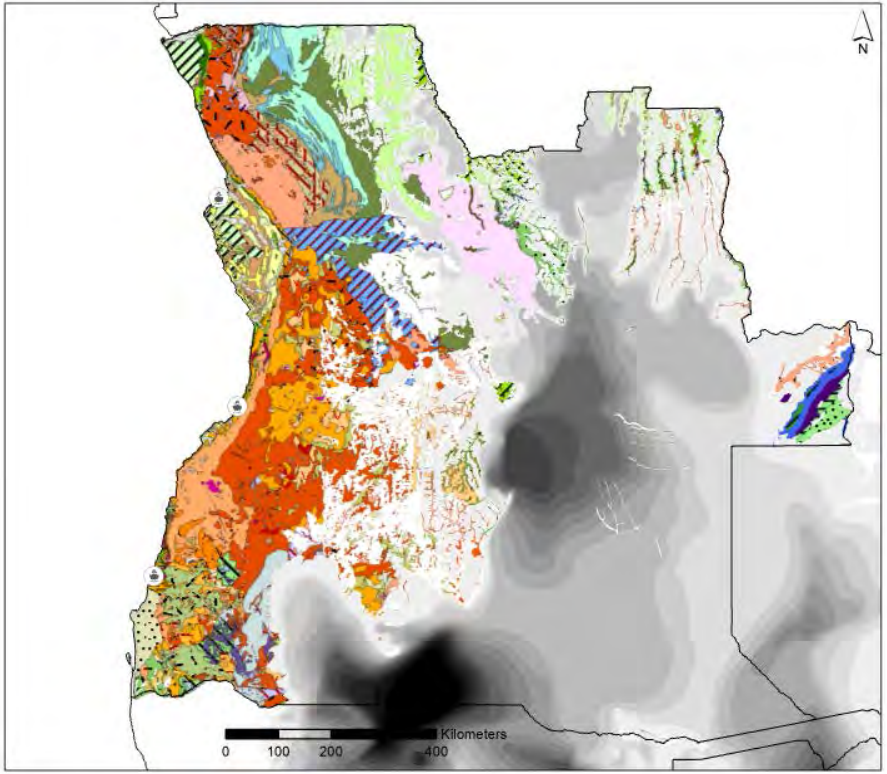
Angola Geology





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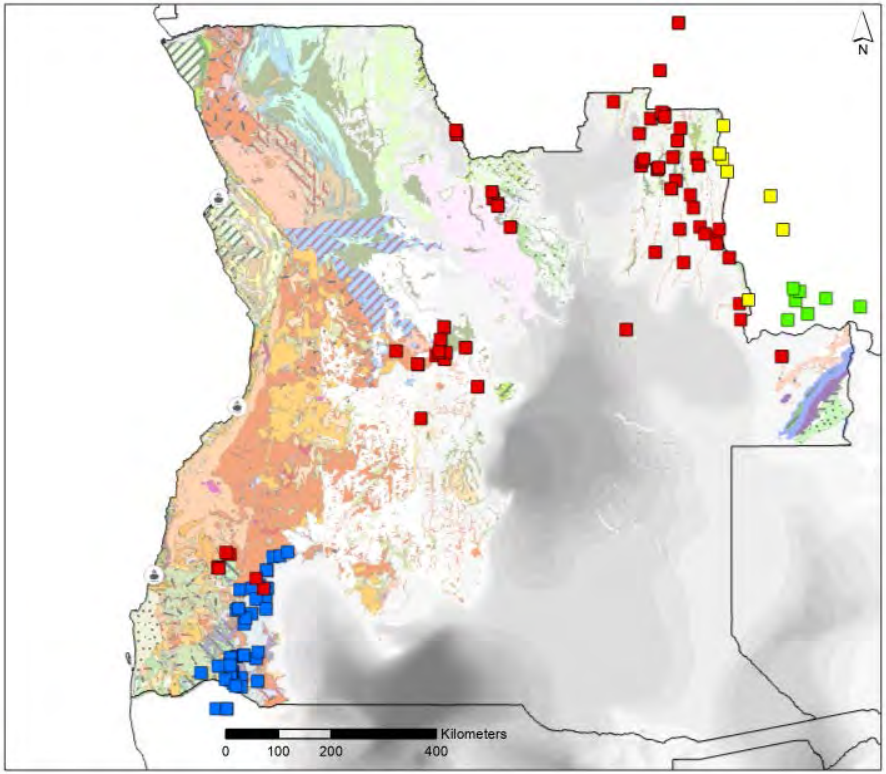
Central Africa Geochronology



This study*

Not included:

Martin Klausen and students

Ariel Boven**

CIMERA research team

*McCourt S, Armstrong RA, Jelsma H, Mapeo RBM (2013). New U-Pb SHRIMP ages from the Lubango region, southwest Angola: insights into the Palaeoproterozoic evolution of the Angolan Shield, southern Congo Craton, Africa. Geol. Soc. London, 170, 353-363, doi: 10.1144/jgs2012-059

*Jelsma HA, McCourt S, Perritt SH, Armstrong RA (2018). The Geology and evolution of the Angolan Shield, Congo Craton. In: Siegesmund S. et al. (eds.), Geology of Southwest Gondwana, Regional Geology Reviews, 217-239. Springer.

**Boven A, Liégeois JP, He H, Yang J, Jelsma H, Armstrong R. (2011). The southern Kasai shield: a metacratonic boundary of the Congo craton?. , International Conference on Craton Formation and Destruction - ICCFD, p.161-162, Institute of Geology and Geophysics, Chinese Academy of Sciences, abstract and poster





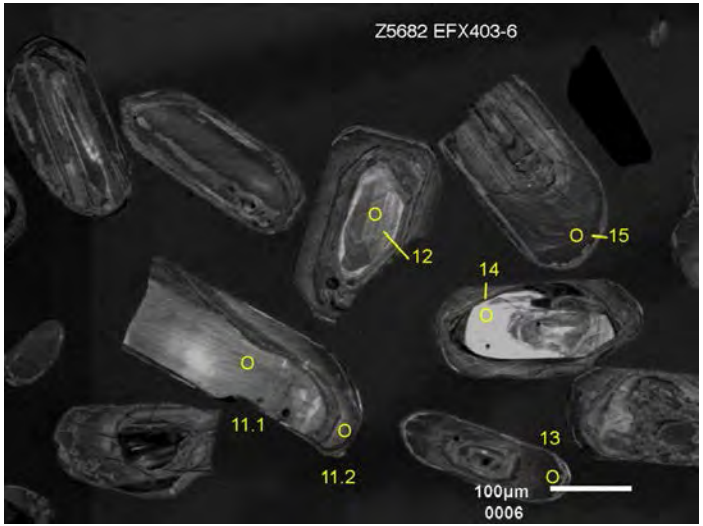

Geochronology

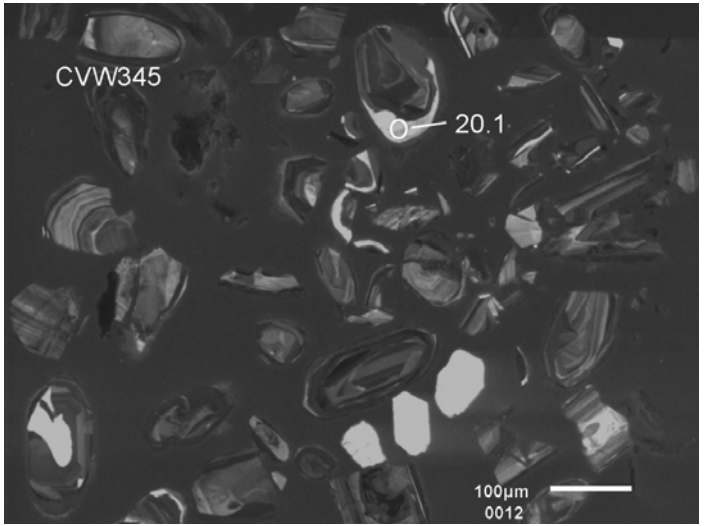
Geochronology

- 10 geological surveys were conducted (2007-2014) in Angola and DRC
- As part of the work program, samples were systematically collected for petrography and a selection submitted for geochronology studies
- All analytical work was conducted at ANU using the SHRIMP zircon method, using one instrument and all were analyzed and processed by Dr. Richard Armstrong
- 250 samples were collected
- 147 samples were analyzed for whole rock lithogeochemistry
- 63 samples were analyzed for geochronology

SHRIMP studies with Richard Armstrong						
Source		AADB	AADB	UKZN	RMCA	Total
Collaborators		This Study	This Study	McCourt	Boven	Combined
Domain	**Interpretation**	Samples	Ages	Ages	Ages	Ages
Kasai Craton	Emplacement	38	38		5	43
	Inheritance	20	25			25
	Provenance	7	35			35
	Metamorphic	8	9			9
	Subtotal	*46*	*107*	*0*	*5*	*112*
Angolan Shield	Emplacement	11	11	4		15
	Inheritance	7	12			12
	Provenance	2	13	2		15
	Subtotal	*17*	*36*	*6*	*0*	*42*
	Total	**63**	**143**	6	5	**154**


CVZ601
CVZ602
CVZ603
CVZ604
CVZ605
CVZ606
CVZ607
CVZ608
CVZ609
CVZ851
CVZ852
CVZ853
CVZ854
CVZ855
CVZ856
CVZ857
CVZ858
CVZ753
CVZ754
CVZ755
CVZ756
CVZ757
CVZ758
CVZ757-759
CVZ 759
EI0001
EI0003
EI0004
EI0005
EI0006
EI0007
EI0008
EI0009
EI0010
EI0011
EI0012
EI0014
EI0016
EI0017
EI0018
granite
dyke
CVW345 = Banded
CVW346 = Amphibolite
CVW436
CVW364
CVW347 = Banded
CVW431
CVW365
CVW437
CVW433
EI0008
EI0011
CVW435
EI0009
CVW349 = Banded
CVW350
CVW351 (cf. CVW352)
CVW353 (cf. CVW352)
CVW355
CVW356
CVW357
CVW358 = Greenstone belt basalt?
CVW421
CVW352
CVW425
CVW427
CVW424
CVW414
CVW426





South Kasai gneisses

Gneiss (South Kasai)

Magmatic age = 2996 ± 3 Ma

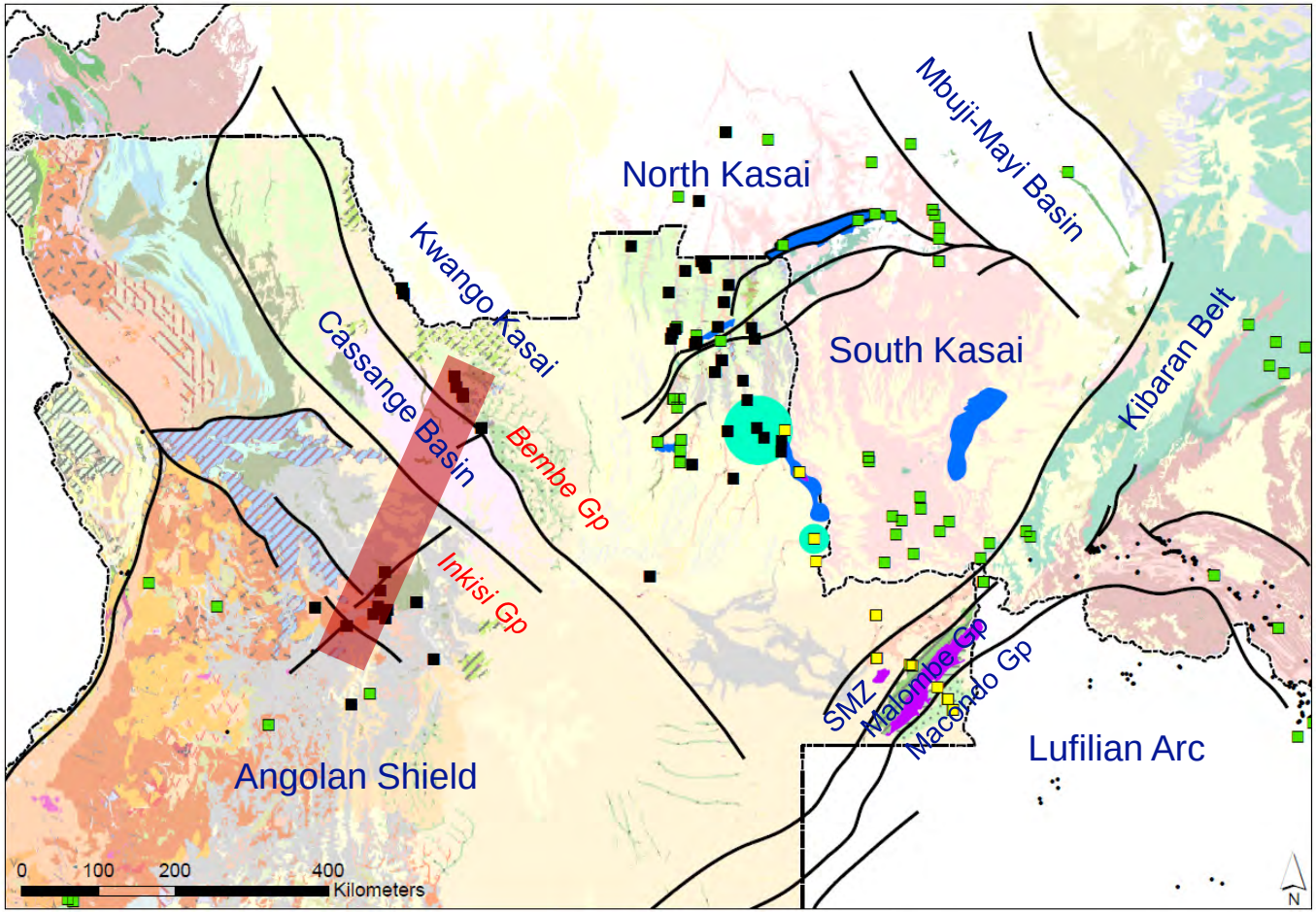
Inheritance at:
#14: 3366 Ma
#11.1: 3364 Ma

Granite

Magmatic age = 2747 ± 8 Ma

Metamorphism at:
#20.1: 2098 Ma

Cathodoluminescence is an optical and electromagnetic phenomenon in which electrons impacting on a luminescent material, cause the emission of photons which may have wavelengths in the visible spectrum

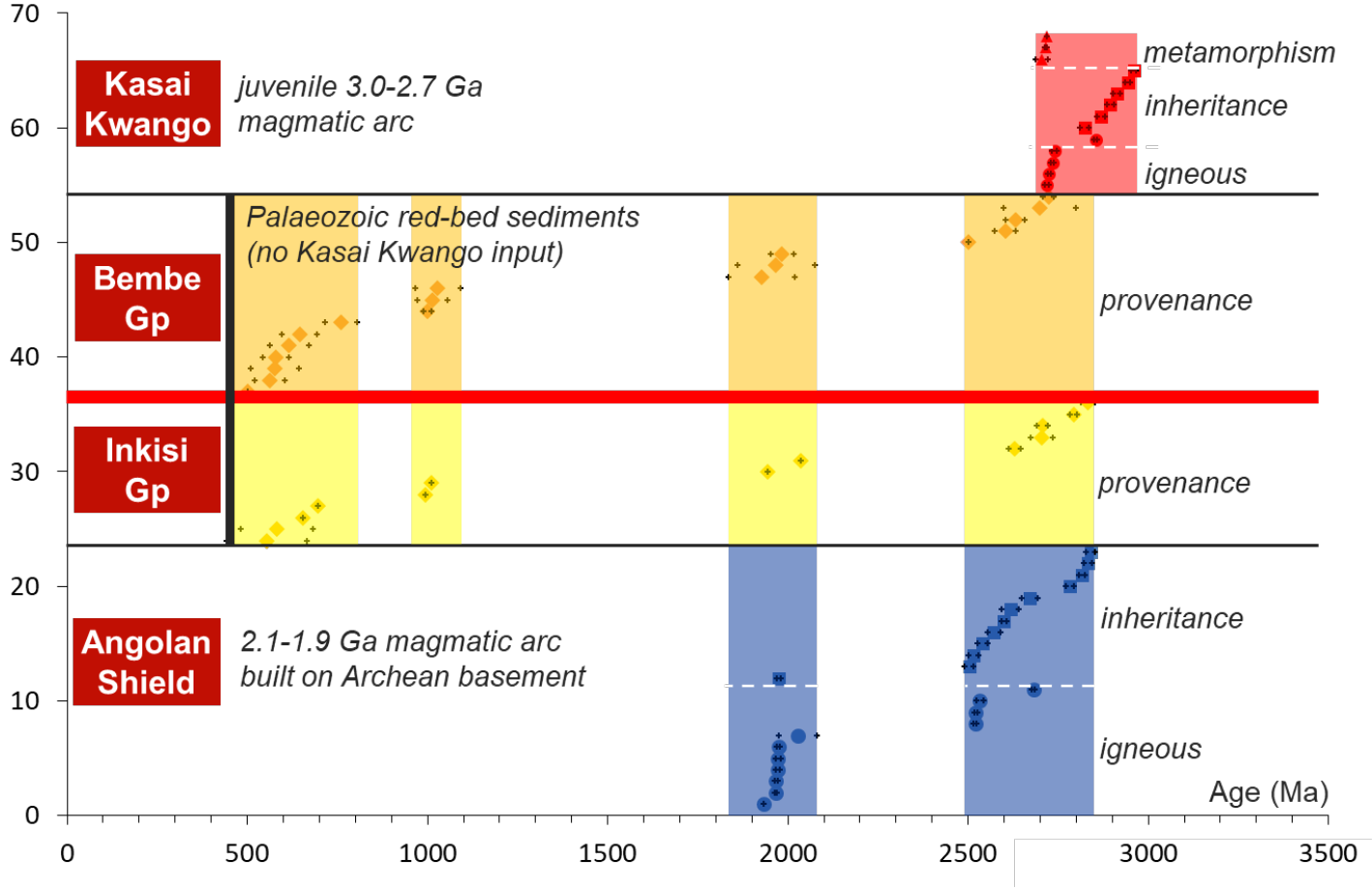


Time chart 1 comparison across Cassange basin:

- Angolan Shield in west
- Kasai Kwango in east

Central Shield Zone in Angola: Archean (left) and Proterozoic (right) gneisses and granites

Kwango Kasai in Angola: gneisses and granulites along Kwango River



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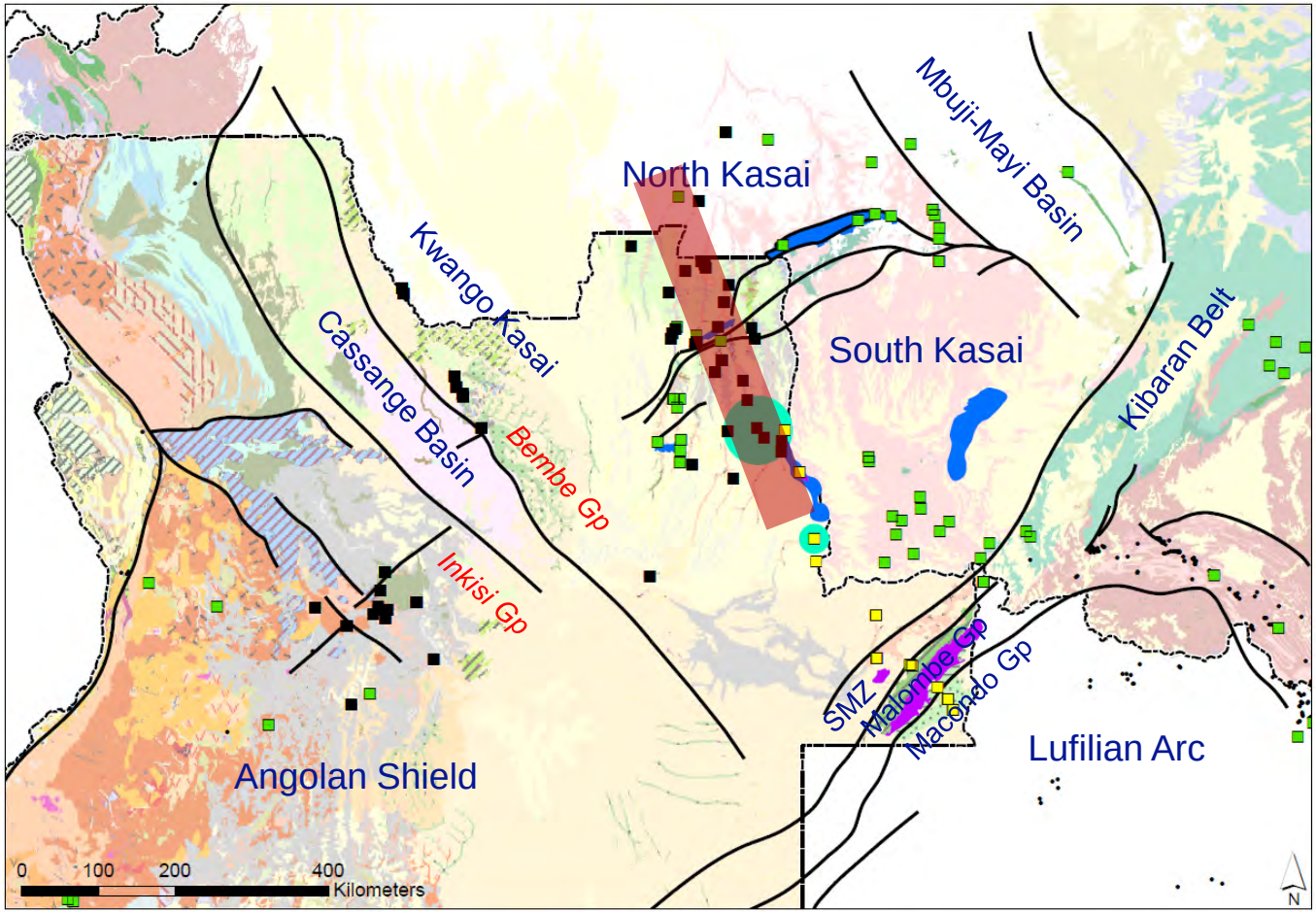
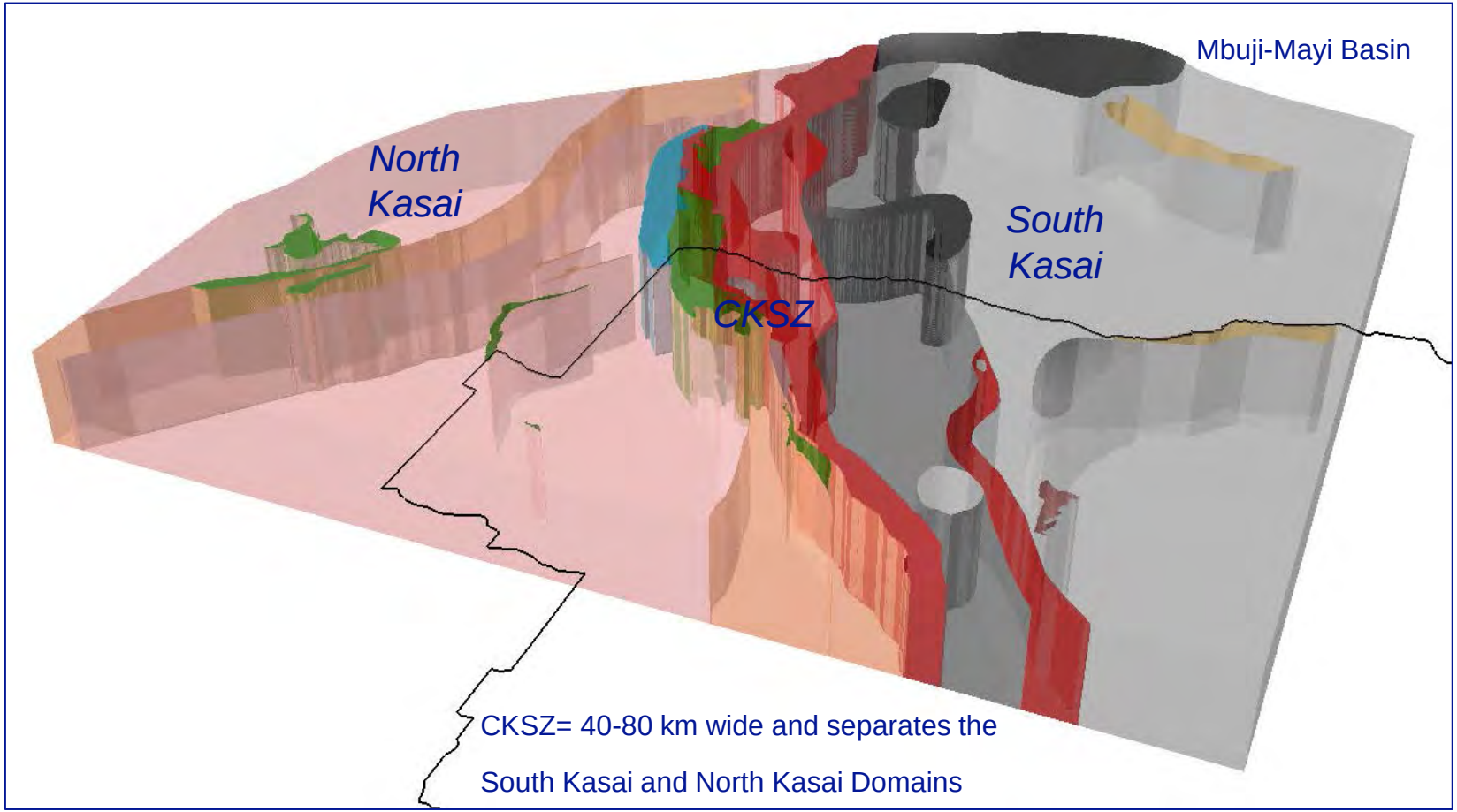
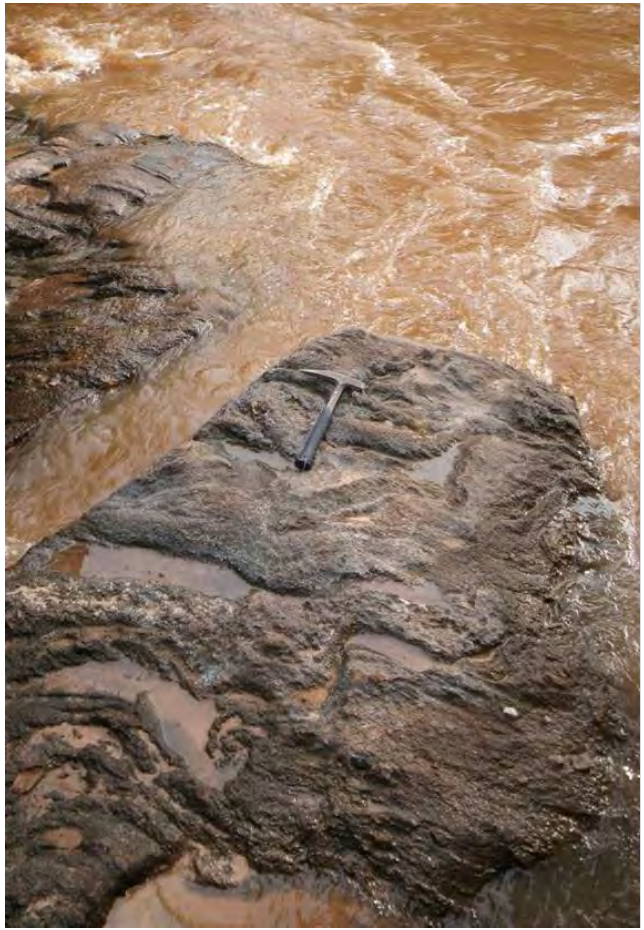


Time chart 2 comparison across Central Kasai Shear Zone (CKSZ)

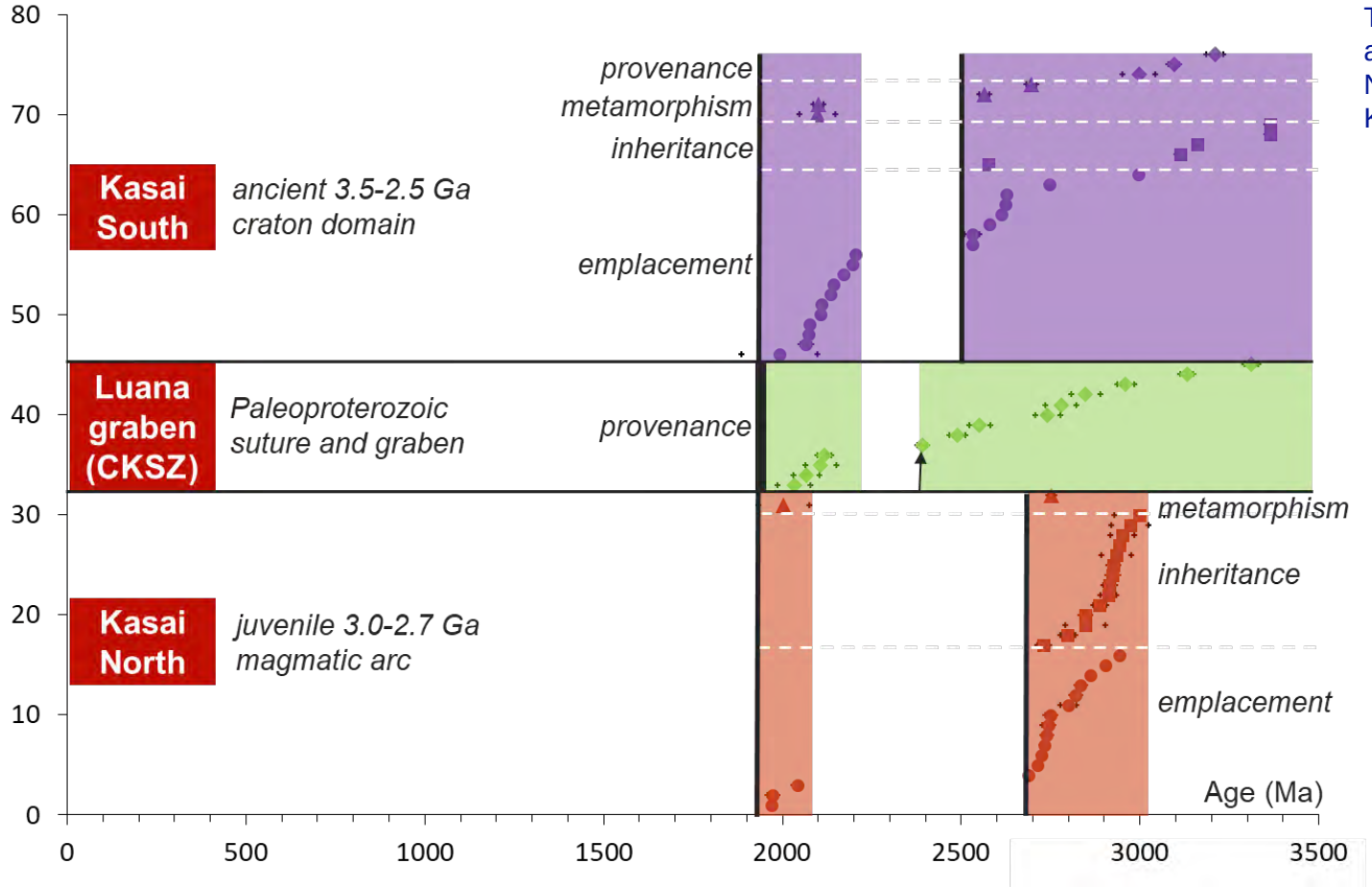
- North Kasai
- South Kasai


Mbuji-Mayi Basin
North Kasai
South Kasai
CKSZ
CKSZ= 40-80 km wide and separates the
South Kasai and North Kasai Domains



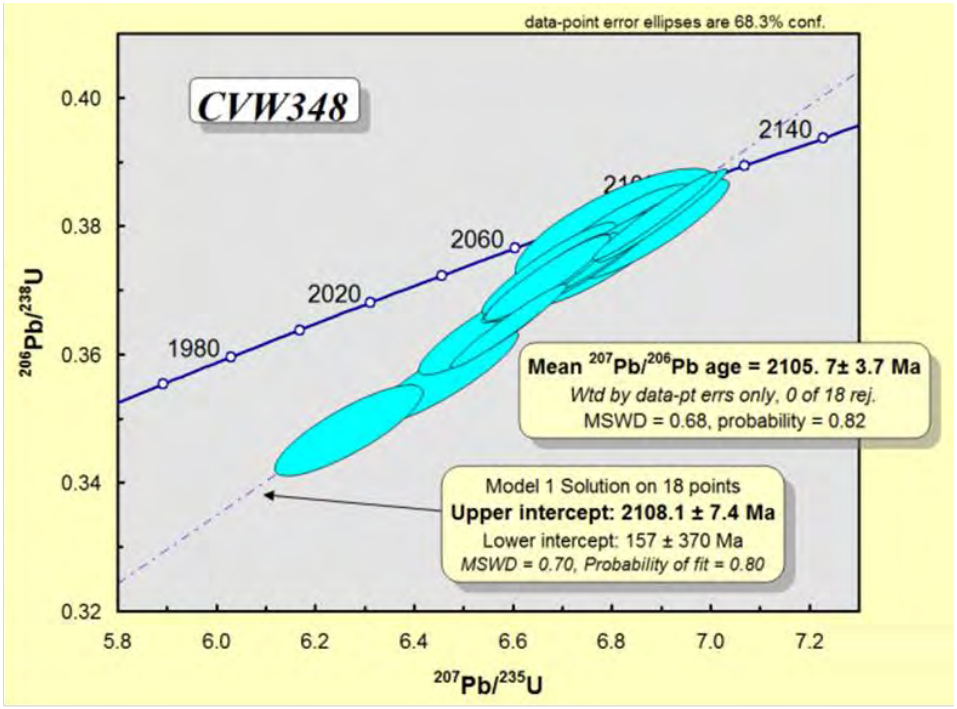
North Kasai gneisses and granites

South Kasai gneisses



Time chart 2 comparison across CKSZ, separating North Kasai and South Kasai domains

Example: Hornblende gneiss intrusive in CKSZ



Discussion and Conclusions

Discussion and Conclusions

Three crustal tectonic domains may be distinguished

1. **3.5-2.5 Ga** ancient South Kasai Domain
   intruded by 2.5 Ga Rapakivi granites (significance?) and by 2.1-1.97 Ga granites
   bearing certain resemblance to Sebakwe Domain of Zimbabwe Craton
2. **3.0-2.7 Ga** juvenile North Kasai + Kwango Kasai domains
   2.5 Ga Rapakivi granites absent, 2.1-1.97 Ga granites present
   bearing certain resemblance to Western Domain of Zimbabwe Craton
3. **c. 1.97 Ga** Angolan Shield continental arc system built on 2.8-2.5 Ga substrate

Discussion and Conclusions

- NKD and SKD may have accreted at ~2.1 Ga along CKSZ, suggested by the age of syntectonic hornblende gneisses (diorites), within CKSZ..
- The associated red-bed Lulua-Luana graben was dated as <2.0-1.9 Ga.
- North Kasai and South Kasai domains may have accreted at ~2.1 Ga
- Angolan Shield and Kasai Craton may have accreted at ~1.97 Ga
- Of note are the marked differences between the different domains, in terms of lithologies, their geochemistry, as well as age constraints and structural geometries mapped.

Thank you