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A Sequence Stratigraphic View of the Roan Group — Host to the World's Largest Sedimentary Rock-hosted Stratiform Copper District, Central Africa

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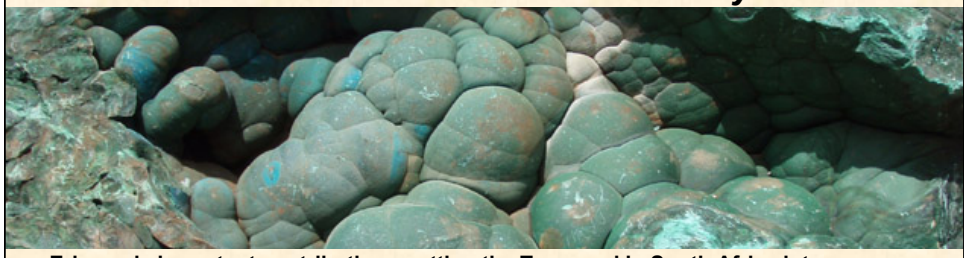
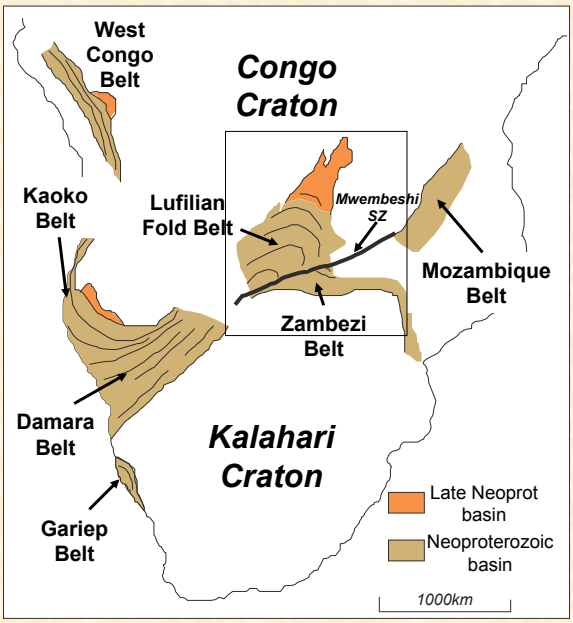
Sequence Stratigraphy, Ore Deposits, and Africa — *The Influence of Dr. Eric Cheney*



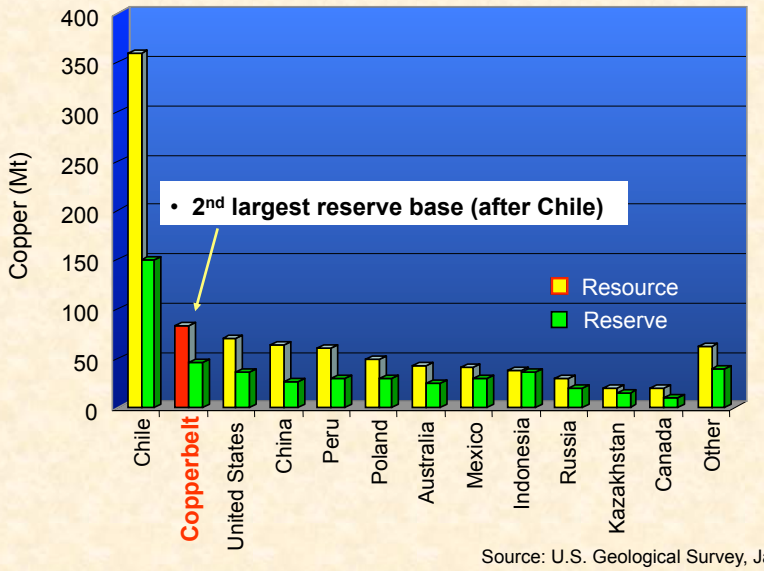
- Eric made important contributions putting the Transvaal in South Africa into a sequence stratigraphic framework and linking the Transvaal sequence to the Hamersley sequence of Australia.
- I began working about twenty years ago a bit to the north on slightly younger Neoproterozoic rocks in another major ore district – the Central African Copperbelt.
- Following Eric's lead I realized the importance of understanding the sequence stratigraphy of the sedimentary rocks hosting this world class district, but this is difficult in Neoproterozoic rocks when outcrop is poor, there are few volcanic rocks to allow acquisition of detailed geochronological data, and there is no available seismic data.
- This analysis is the result of detailed logging of many thousands of meters of drill core from exploration holes across the region by myself and especially my PhD students Jon Woodhead and David Broughton.



Tectonic Setting of the Central African Copperbelt

The Central African Copperbelt is hosted within the Lufilian Fold Belt — one of a series of deformed Neoproterozoic basins at the periphery of Congo and Kalahari cratons.

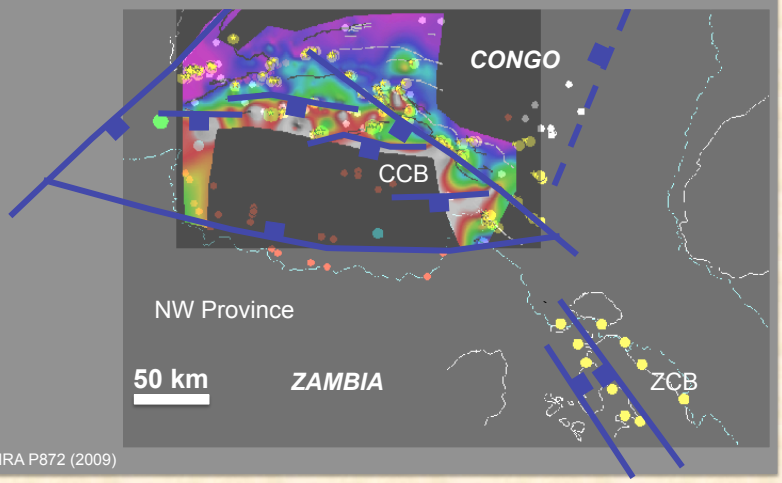
Economic Importance of the Central African Copperbelt



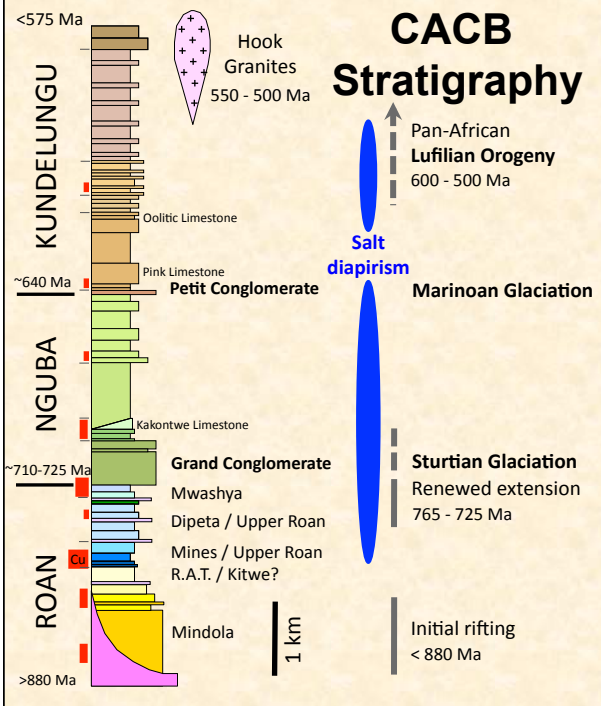
Source: U.S. Geological Survey, January 2008

Central African Copperbelt Basin

Neoproterozoic African Copperbelt (Katangan) basin appears to be a trap-door basin, hinged to the south. The Congolese Copperbelt (CCB) was in the main basin while the Zambian Copperbelt (ZCB) was a sub-basin on the southeast shoulder of the main basin.



AMIRA P872 (2009)



CACB Stratigraphy

Pan-African
Lufilian Orogeny
600 - 500 Ma

Salt diapirism

Marinoan Glaciation

Sturtian Glaciation
Renewed extension
765 - 725 Ma

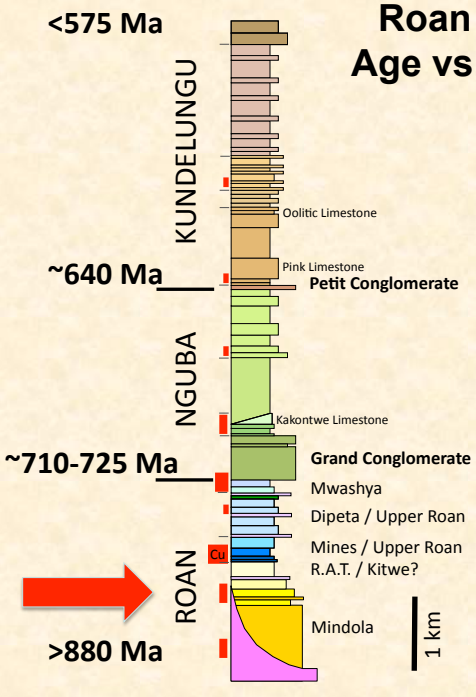
Initial rifting
< 880 Ma

- **Neoproterozoic Katangan Supergroup ~5-6 km thick (present day).**
- **Exact age of sediments poorly constrained (< 880 - 575 Ma) → up to 300 million years.**
- **Global correlation based on diamictites of glaciogenic origin ("Snowball Earth").**
- **Records a complex history of extension prior to orogeny and metamorphism.**
- **Copper deposits mostly in early rift-phase to rift-climax strata but occur throughout the stratigraphic column.**

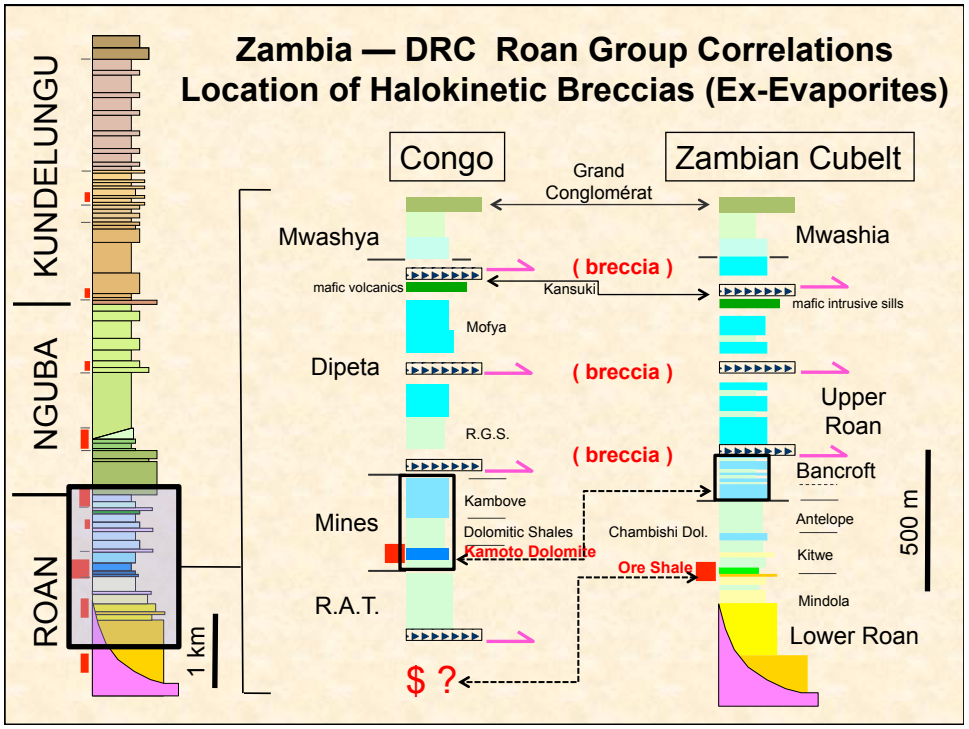
CACB Roan Group Stratigraphy

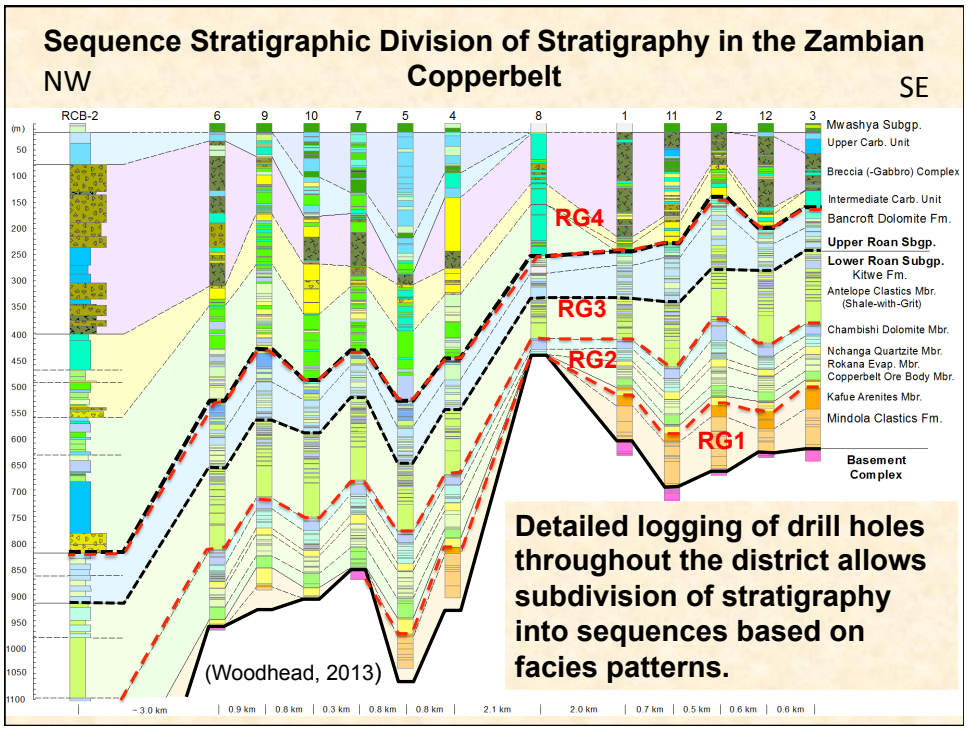
- Top of the Roan Group is marked by a basinwide glaciogenic unit (Grand Conglomérat diamictite) that forms basal unit of overlying Nguba Group.
- Upper portion of the Roan Group contains ~760 Ma mafic volcanic rocks. Few to no tuffs recognized within Roan Group to utilize as marker units.
- Absence of fossils (Neoproterozoic section) and lack of seismic data makes regional correlations difficult.
- Abundance of halokinetic breccias indicate original significant thicknesses of evaporites in stratigraphic section.
- Detailed logging of lithostratigraphy throughout the region has been utilized to attempt a sequence stratigraphic analysis.

Roan Group – Problem of Age vs. Preserved Thickness

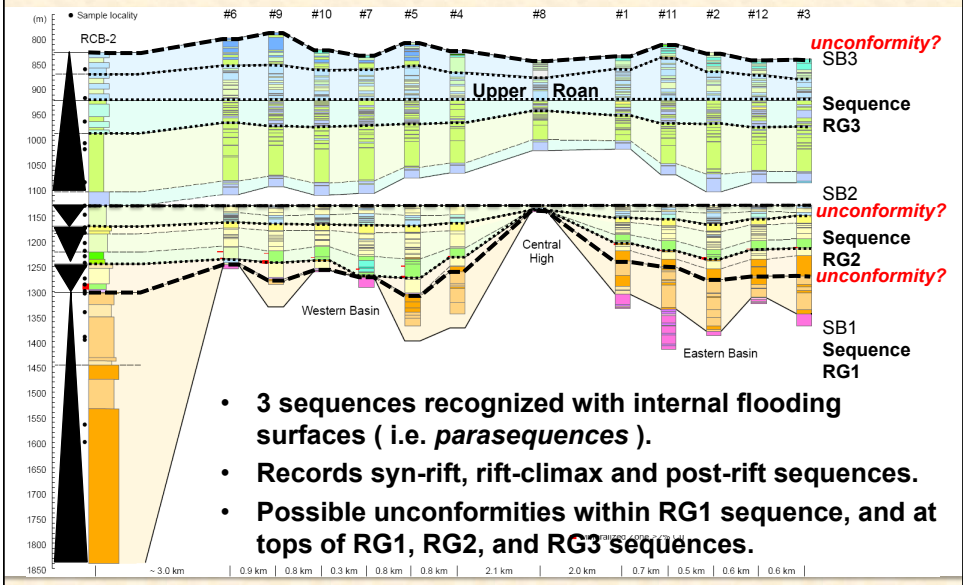


- Preserved thickness of 2-3 km.
- Probable that there were significant thicknesses of evaporites within the section that are not preserved.
- Deposited within as much as approximately 150 m.y.
- Suggests geologically unreasonably slow depositional rates, deposition started significantly after 880 Ma, or previously unrecognized significant disconformities or unconformities within the section.


Zambia — DRC Roan Group Correlations
Location of Halokinetic Breccias (Ex-Evaporites)
KUNDELUNGU
NGUBA
ROAN
1 km
Congo
Zambian Cubelt
Grand Conglomérat
Mwashya
Mwashia
(breccia)
mafic volcanics
Kansuki
mafic intrusive sills
Mofya
Dipeta
(breccia)
Upper Roan
R.G.S.
(breccia)
Bancroft
Kambove
Mines
Dolomitic Shales
Chambishi Dol.
Antelope
Kamoto Dolomite
Ore Shale
Kitwe
500 m
R.A.T.
Mindola
Lower Roan
$?


Sequence Stratigraphic Division of Stratigraphy in the Zambian Copperbelt
NW
SE
RCB-2
RG4
RG3
RG2
RG1
Mwashya Subgp.
Upper Carb. Unit
Breccia (-Gabbro) Complex
Intermediate Carb. Unit
Bancroft Dolomite Fm.
Upper Roan Sbgp.
Lower Roan Subgp.
Kitwe Fm.
Antelope Clastics Mbr. (Shale-with-Grit)
Chambishi Dolomite Mbr.
Nchanga Quartzite Mbr.
Rokana Evap. Mbr.
Copperbelt Ore Body Mbr.
Kafue Arenites Mbr.
Mindola Clastics Fm.
Basement Complex
(Woodhead, 2013)
Detailed logging of drill holes throughout the district allows subdivision of stratigraphy into sequences based on facies patterns.

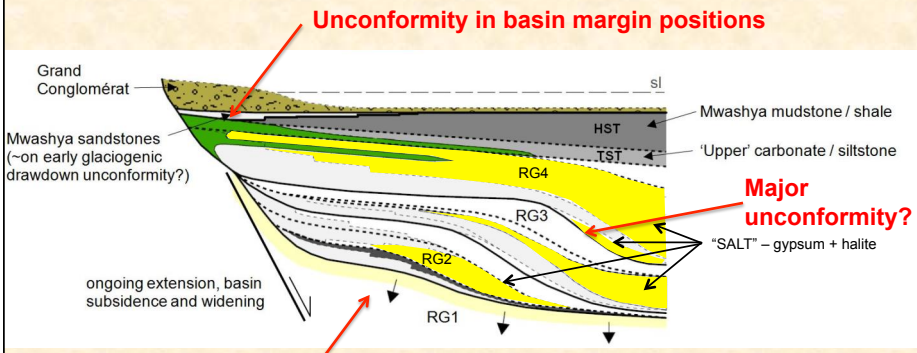
Roan Group Sequences and Possible Unconformities

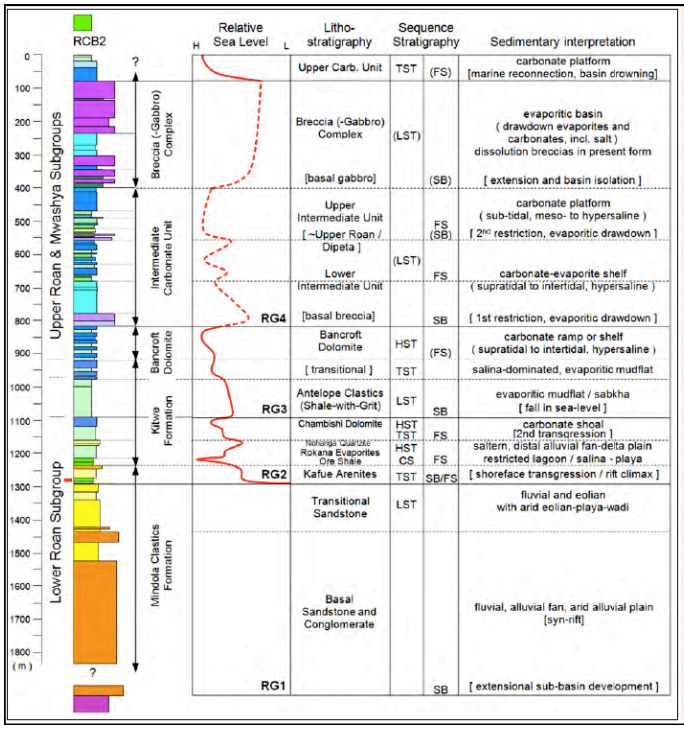


- 3 sequences recognized with internal flooding surfaces (i.e. *parasequences*).
- Records syn-rift, rift-climax and post-rift sequences.
- Possible unconformities within RG1 sequence, and at tops of RG1, RG2, and RG3 sequences.

Major unconformities most likely within RG1 sequence (subaerial) and top RG3 sequence – position of major evaporitic drawdown.

Probable Positions of Major Unconformities within the Roan Group





Basin margin only

Probable Positions of Significant Unconformities in the Roan Group

CACB Roan Group Sequence Stratigraphy

- **This sequence stratigraphic model allows for alternative correlations between the autochthonous and halokinetically disrupted parts of the Roan Group.**
- **The model also helps to explain the stratigraphic distribution of ore deposits within the basin:**
  - **The "Ore Shale," the dominant host to deposits of the Zambian Copperbelt, occurs near the base of the RG2 sequence above a possible unconformity at the top of the RG1 sequence.**
  - **The Mines Subgroup, the host to most deposits in the Congolese Copperbelt, occurs near the top of the RG3 sequence below a possible unconformity at the top of a major evaporite sequence.**
  - **Redox boundaries associated with the regional unconformity above the RG4 sequence, near the base of the glaciogenic Grand Conglomerate Formation of the Nguba Group, control major ore deposits in basin margin positions.**
- **Further work on the sequence stratigraphy of Central African Copperbelt should lead to additional insights into mineralization processes in this economically important basin.**