Practical Mineral Systems Targeting for Base Metals in Sedimentary Basins
Neal Reynolds & Peter Muhling
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Practical Mineral Systems Targeting?

Complexity of mineral systems with multiple independent variables

Heuristic and empirical targeting that incorporates mineral system understanding; practical and effective approach from first principles

SHMS/IRT Basin Mineral Systems as an example – few known fertile basins, all rift-sag basins with very specific features – what are the shared characteristics and how do they fit within Mineral Systems understanding?

Global petroleum basins
Complexity of mineral systems with multiple independent variables

Heuristic and empirical targeting that incorporates mineral system understanding; practical and effective approach from first principles

- Empirical basin-, play-, and deposit-scale criteria are based on observation in fertile basins
- Support from mineral system framework, even if details of complex processes are not fully understood
- Criteria are defined as Essential, Prevalent, or Favourable
- Fertile basins are identified based on criteria related to Source, Trigger, Focus, Trap, and Process
- ‘Plays’ are defined and prioritised along prospective trends or fairways based on Focus and Trap
- Plays defined at a scale that can be identified with available data and tested for concept validity
- Deposit-scale targeting integrates direct alteration and deposit signature

Improve identification of fertile basins and effectiveness of targeting within basins

Look at basin-scale fertility criteria for SHMS and IRT deposits
Source – metals and brines

- Rift fill – immature (arkosic, lithic), mildly oxidised or mildly reduced
- Burial and maturity – rift > c. 4km of sediment
- Basin scale and duration – source volume, polycyclic
- Heat flow and maturity – volcanics and/or intrusions
- Palaeogeography – low latitude setting, evaporites, carbonates

rift lower plate setting

Multiple cycles of the Selwyn basin (associated with alkali volcanism); Cecile et al. 1997
Source – metals and brines

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Focus and fluid pathway – basin architecture and plumbing

- Structural architecture – rift and sag basin-architecture faults
- Palaeohighs in rift and sag, sub-basins in sag
- Structural complexity; rift lower plate setting

Betts and Giles 2006
Trigger – tectonic event

- Basin architecture faults, palaeohighs, sub-basins in sag
- Basin age – periods of supercontinent rifting

Nuna break-up, Idnurm (2000)

Multiple cycles of the Isa Superbasin Betts & Lister, 2002
Trigger – tectonic event

- Basin architecture faults, palaeohighs, sub-basins in sag
- Basin age – periods of supercontinent rifting

Trap – chemistry, sulphur

- Reduced sediment intervals in sag – dolomitic carbonaceous siltstones and mudstones; basin anoxia
- Sediment-hosted barite, carbonates
- Hydrocarbons
Basin-scale Criteria

Trigger – tectonic event
- Basin architecture faults, palaeohighs, sub-basins in sag
- Basin age – periods of supercontinent rifting

Trap – chemistry, sulphur
- Reduced sediment intervals in sag – dolomitic carbonaceous siltstones and mudstones; basin anoxia
- Sediment-hosted barite, carbonates
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Process – fluid-flow events
- Fluid-flow event – dolomitisation, hydrocarbon occurrences
- Mineralisation (any style), conformable Pb isotope signature
Focus and fluid pathway

- Major basin-architecture fault zones – rift into sag; lithostratigraphic/lithofacies and structural domain boundaries;
- Fluid-gathering and focusing; palaeohighs, accommodation zones
Focus and fluid pathway

- Major basin-architecture fault zones – rift into sag; lithostratigraphic/ lithofacies and structural domain boundaries;
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Trap

- Reduced sediment intervals, sub-basins, low sedimentation rate; magnetics and EM signatures
- Barite or carbonate intervals in local stratigraphy
Focus and fluid pathway

- **Major basin-architecture fault zones** – rift into sag; lithostratigraphic/lithofacies and structural domain boundaries;
- **Fluid-gathering and focusing; palaeohighs, accommodation zones**

Trap

- **Reduced sediment intervals, sub-basins**, low sedimentation rate; magnetics and EM signatures
- **Barite or carbonate intervals in local stratigraphy**

Process

- **Zn-Pb-Ag ±Cu** especially along fault corridors; iron-carbonate alteration; surface or lithogeochemical anomalism in reduced sediments
- **Conformable Pb isotope data, including minor occurrences**
Practical application

– from first principals

➢ Fertile rift-sag basins can be identified using basic data, geological maps, geophysics supported by field observation and focused collection of new data

➢ Play-scale targeting interpretation can be similarly derived e.g. map patterns ± stratigraphic columns

Parsons Range Group in upper part of rift phase thickens east into the faulted half-graben bounded on the east by the Bath Range fault
Thank You