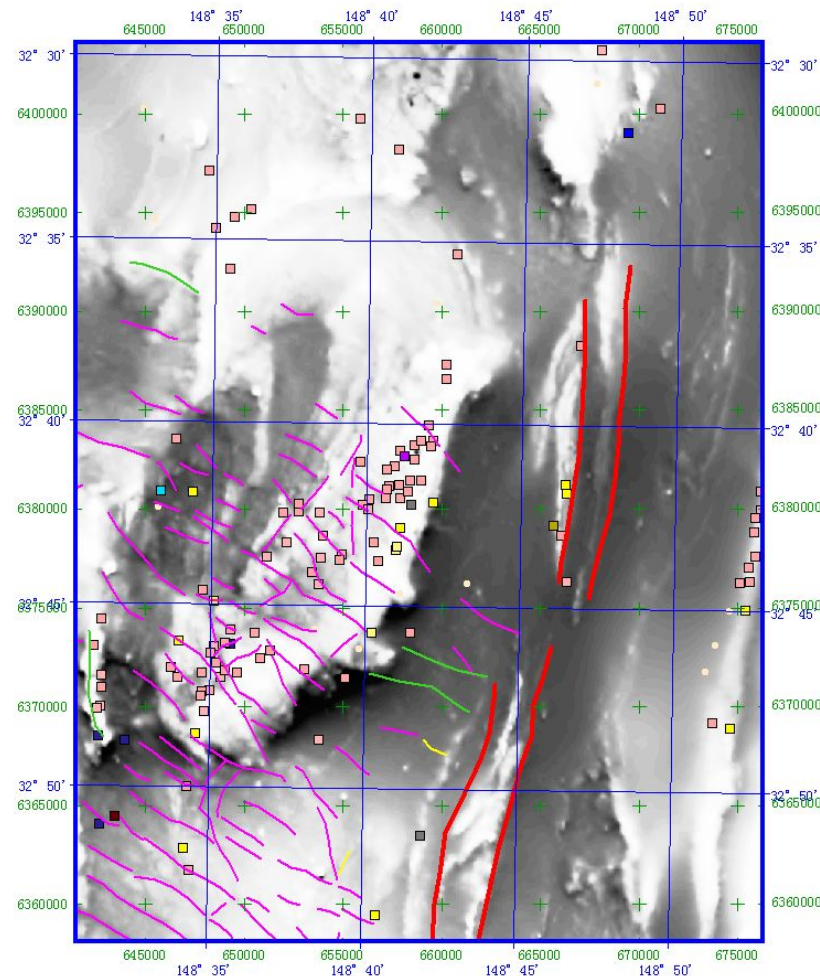


Yoeval Area, N
Lachlan Fold Belt:
TMI Signature

Courtesy:
NSW Geological
Survey





Yoeval Area, N
Lachlan Fold Belt:
Magnetite-
depleted Faults

Courtesy:
NSW Geological
Survey



- Structural Association
 - For IOCG, IAC, and IAG
 - ❖ Regional Scale Faults and Associated fault sets
 - ❖ Demonstrated for IAC and AIG, less so for IOCG
 - ❖ "Barren" intrusives with identical primary mineralogy and textures mostly remote from large faults?



- Structural Association
 - For IOCG, IACG, and IAG
 - ❖ Close association with major faults with several episodes of activity
 - ❖ Vein arrays of several generations
 - ❖ Vein arrays relatable to major faults and far-field stress regimes.
 - ❖ No relation of vein arrays to "Burnham-type" MVP fracturing events



- Textures and Fabrics of Associated Intrusive
 - For IOCG, IACG, and IAG
 - ❖ Phaneritic, porphyritic, seriate-to hiatal textured
 - ❖ No aplitic rocks: not observed for IOCG and not for most IAG or IAC
 - ❖ Dykes are simple, phaneritic uniform to porphyritic to seriate texture



- Textures and Fabrics of Associated Intrusive
 - For IACG, and IAG
 - ❖ "Macro" marialitic cavities NOT present
 - ❖ Two domain textures (cf Mole Granite (Candela)) NEVER observed in Chile & SW USA IAC(G)
 - ❖ "Primary" mineralogy and textures identical: mineralised & barren !



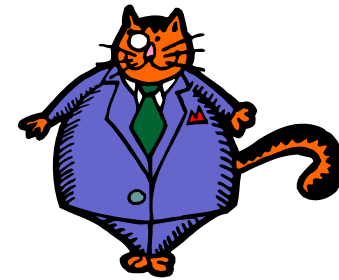
A Tentative Model

- "Magmatists" Need to Explain:
- Host lithological assemblage oxidation state control!
- Structural association!
- Re/Os, Pb, $\delta S34$, Sm/Nd indicating mixed magmatic rock & shallow crustal rocks!
- Identical 'primary' mineralogy, texture, and geochemistry of "barren" and "mineralised"
- "Magmatic textured" systems, e.g. Timbarra, Lightning Creek tiny, or extremely low grade, or barren of Cu, Au!



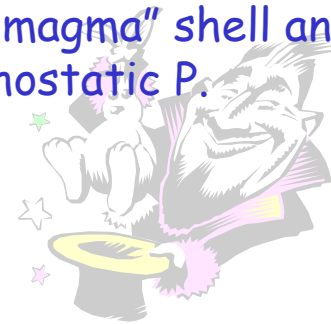
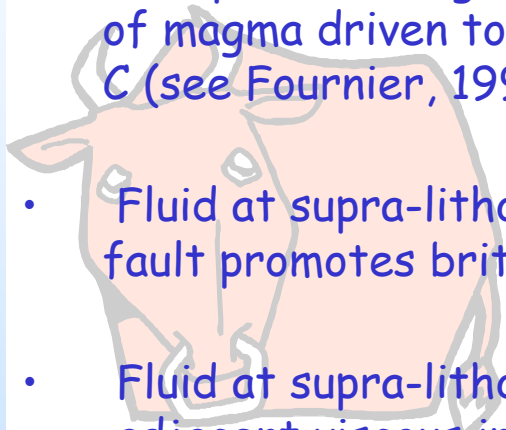
A Tentative Model

- Magma emplaced across or next to major contractional or strike slip fault
- Depth 5 to 10 km or so!
- Fluid filled compartments in fault
- Cycling from sub-hydrostatic to supra-lithostatic P (say lithostatic P + 20 MPa)
- Fluid P increase (expansion) also driven by heating from adjacent intrusive



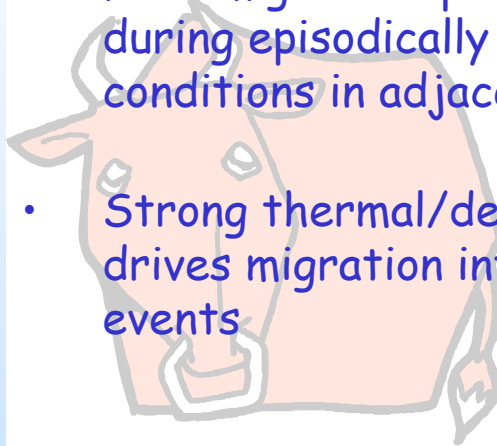
A Tentative Model

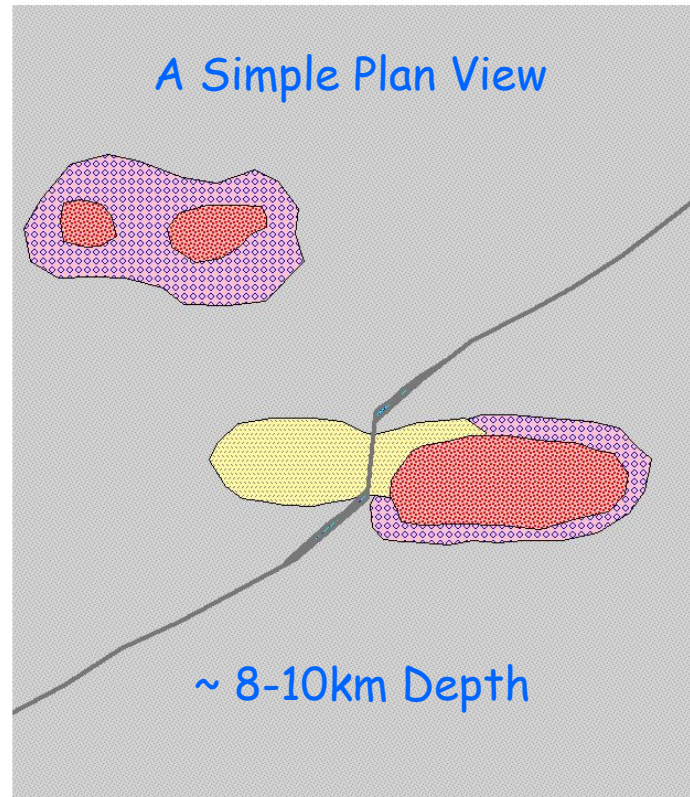
- In slip events, high strain rate/damage in adjacent shell of magma driven to brittle behaviour, at $T \sim 600-700$ C (see Fournier, 1999 Fig 3; Sibson 2000 Fig 4)
- Fluid at supra-lithostatic P in extension fractures & fault promotes brittle behaviour in "magma" shell
- Fluid at supra-lithostatic P driven into "magma" shell and adjacent viscous interior which is at lithostatic P.



A Tentative Model

- Fluid migrates upwards in solid shell of the "magma" during episodically brittle conditions & under ductile conditions in adjacent viscous interior
- Strong thermal/density gradients in fluid path drives migration into the "magma" during the fault slip events





- Suprasolidus Interior
- Dextral Strike Slip-Contractional Fault
- Fluid at Supralithostatic Pressure
- Zone of Shear Fracture-Crush Breccia
- Felsic or Intermediate Intrusive
- Magnetite-Stable (Copper) or Carbon Stable (Gold) Country Rocks

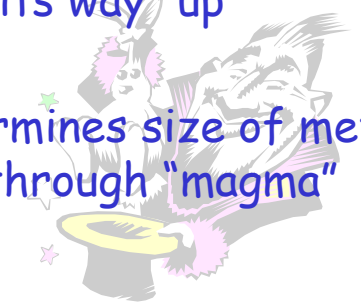
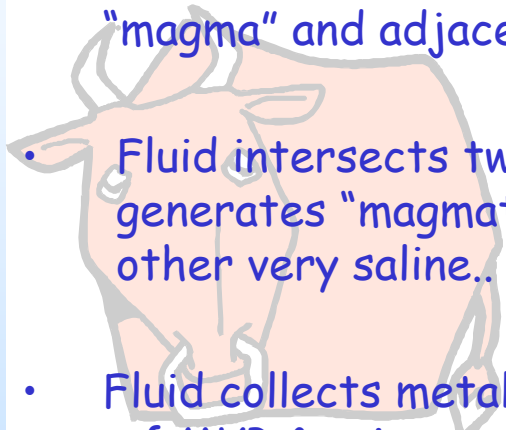
A Tentative 'Model'

- 1: Cooling magma next to contractional fault
- 2: Extension veins in strain damage zone
- 3: Fluid P supralithostatic in fault & veins
- 4: Fluid driven into magma (where Pfluid is lithostatic)
- 5: Magma then acts as a fluid pump ...



A Tentative Model

- Fluid ascends to ~ 3 to 5 km depth in shell of "magma" and adjacent viscous interior.. . . .
- Fluid intersects two phase fluid region at $T \sim 550C$, generates "magmatic" appearing fluids, one gas rich, other very saline.. . . .
- Fluid collects metals & gases from the tiny trapped bubbles of MVP & primary mineral phases on its way "up"
- Initial fO_2 , ΣSO_4 , ΣCl in inflow determines size of metal reservoir in "magma" as it migrates through "magma"



A Tentative Model

- Possible local magma remelting & generation of "remelt" textures on flank of "magma", e.g. Lightning Creek
- Salinity of fluid increasing through loss of water to wall rocks in "magma"
- Initial fO_2 in fluids controlled by magma, either above or below solidus, but subsequently by inflow fluid as R/W decreases in fluid flow paths



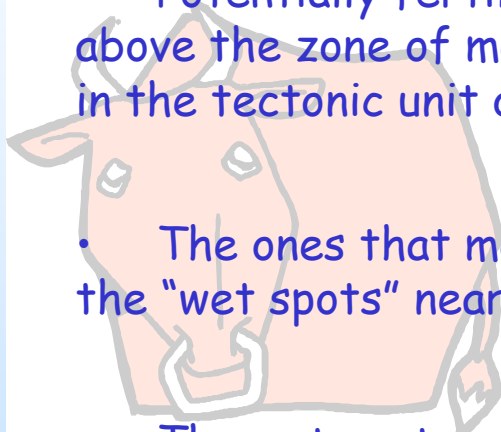
A Tentative Model

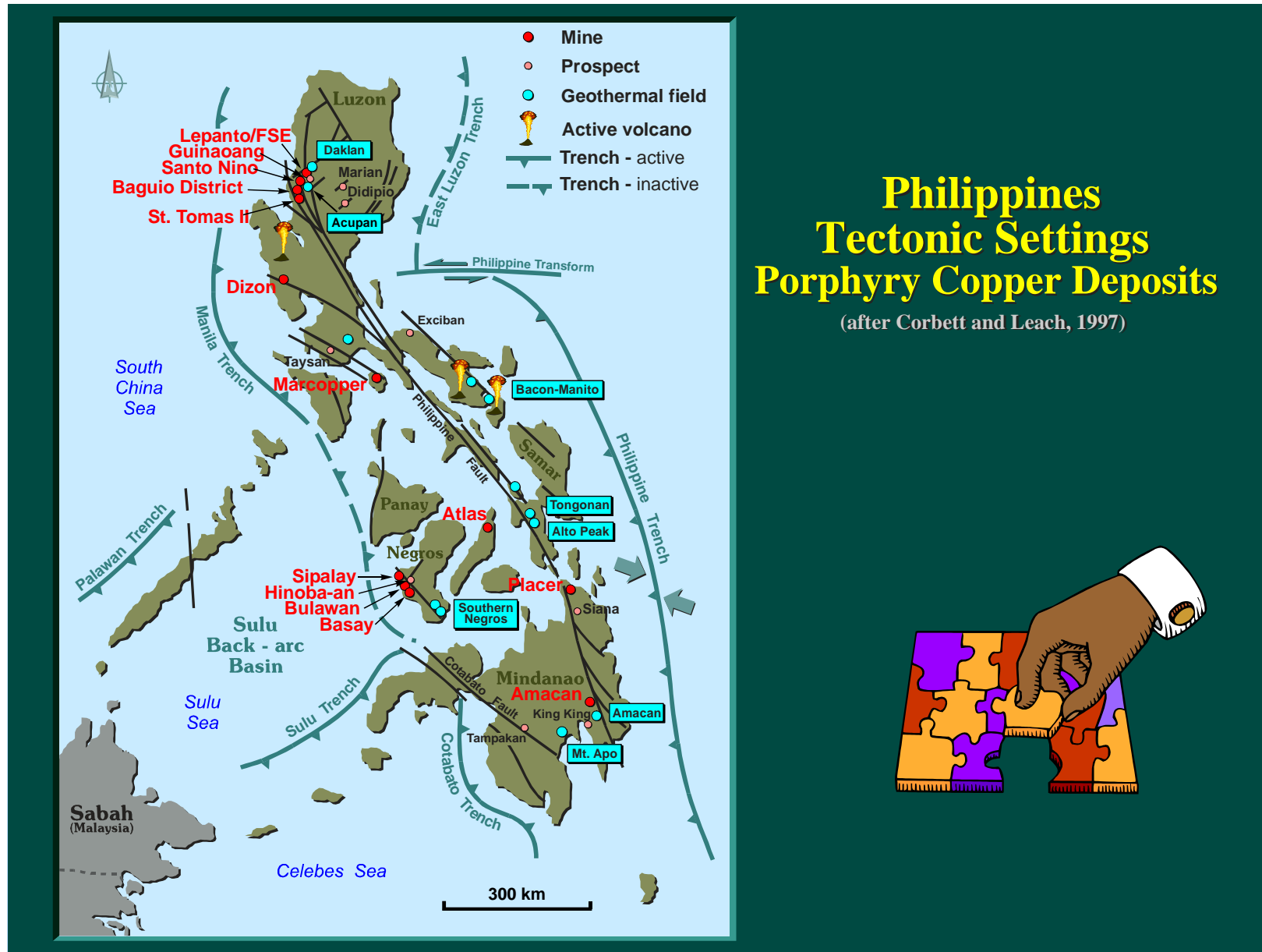
- Bisulphide predominant external fluid, and magnetite-stable magma: weak early Cu; major Au: Porgera, Lihir,
- Bisulphide predominant external fluid, and magma "below" QFM: major Au
- Sulphate predominant external fluid, and magnetite-stable magma: major Cu, Au
- Et cetera.. ..



A Tentative Model

- Potentially fertile magmas distributed randomly above the zone of mantle-lower crust partial melting in the tectonic unit of interest
- The ones that make it, though, are those which hit the "wet spots" near and at the surface
- The wet spots are where faults/joint arrays/lithological contacts are capable as acting as fluid reservoirs with fluid $P >$ lithostatic at episodic intervals

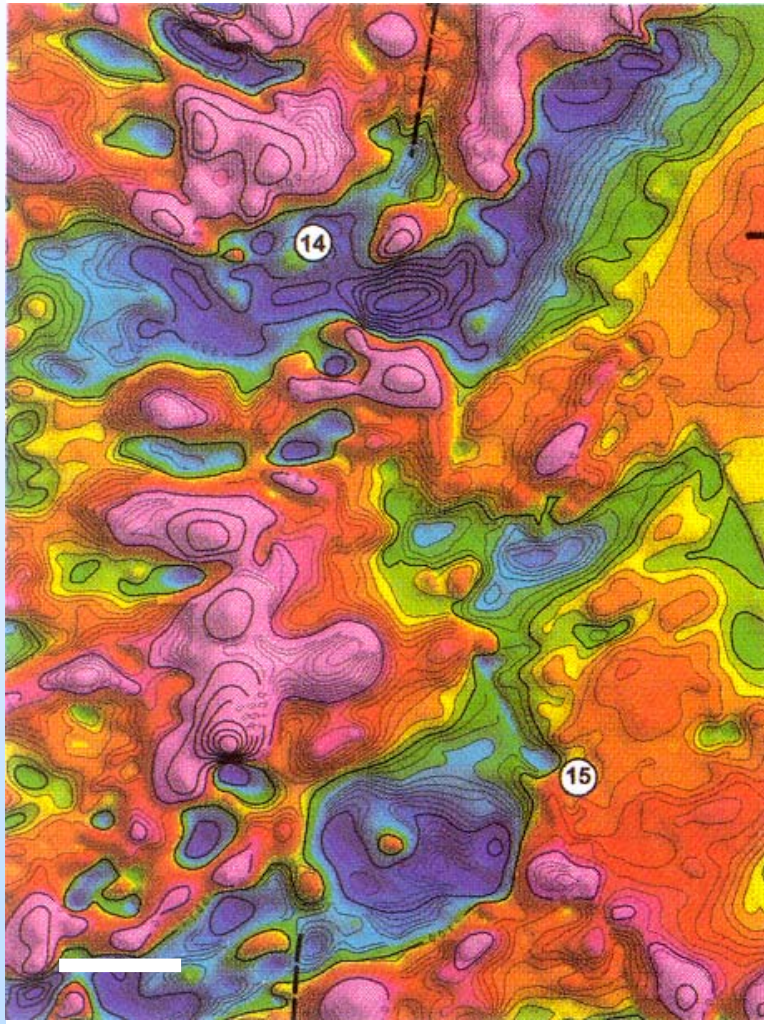




A Tentative Model

- Albite in prograde, deep flow paths (deep veins at El Salvador & deep alteration at Yerington)
- K-spar in retrograde flow paths (at and near top of intrusive body)
- Fluid recharge zones evident in detailed aeromagnetic data ?





El Salvador

Potreriillos

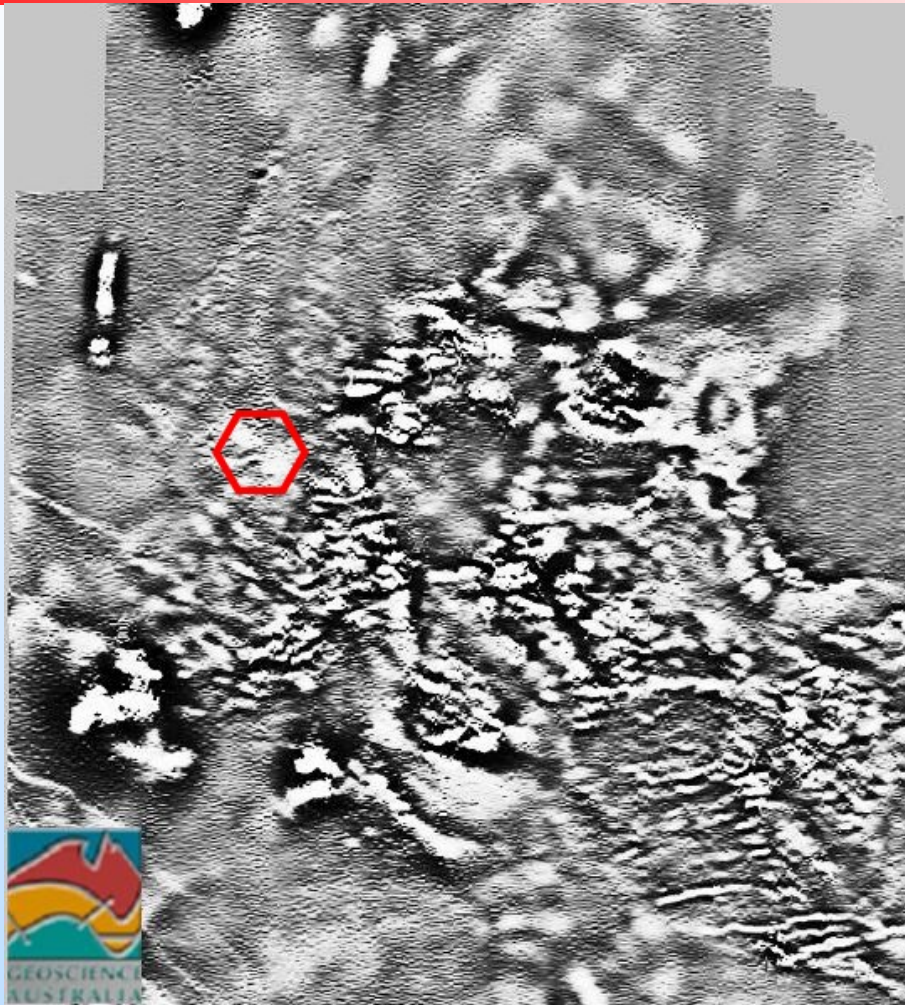


Behn et al., 2001

Ishihara Granites Symposium

July, 2003





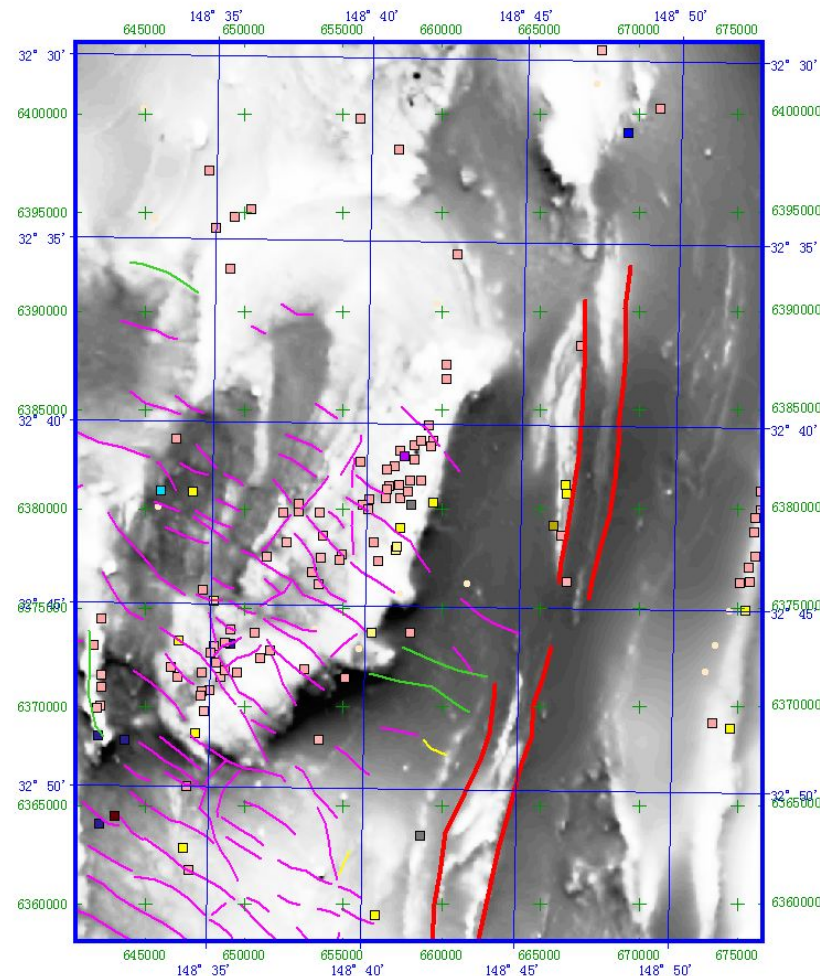
Courtesy:
R Skirrow
N Direen



Ishihara Granites Symposium

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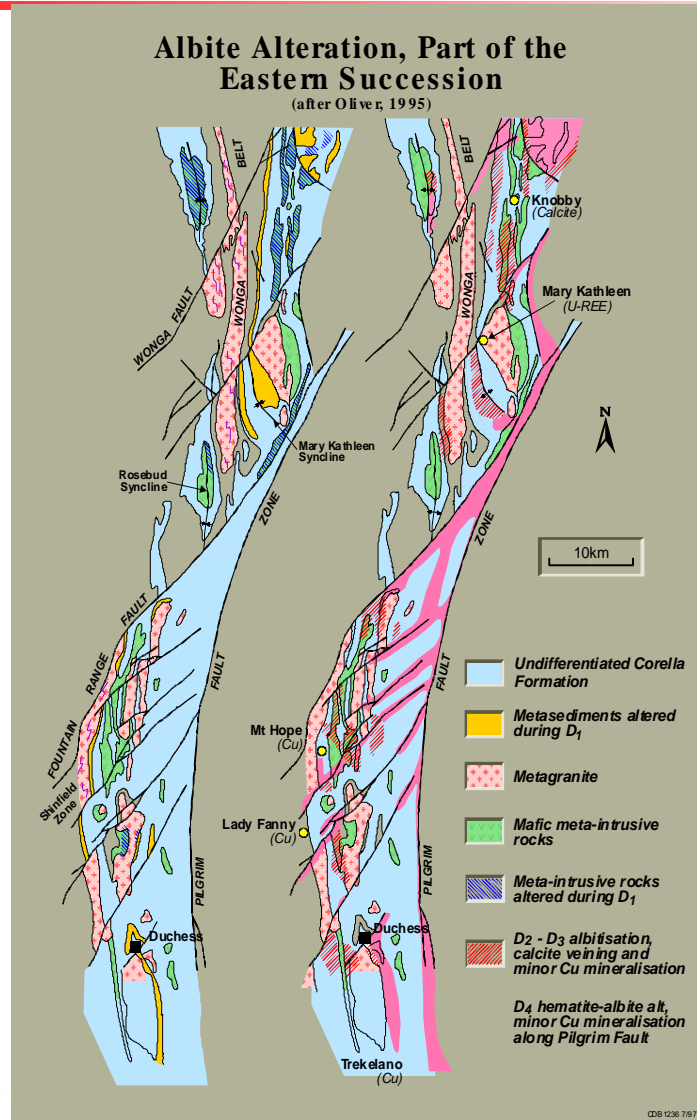


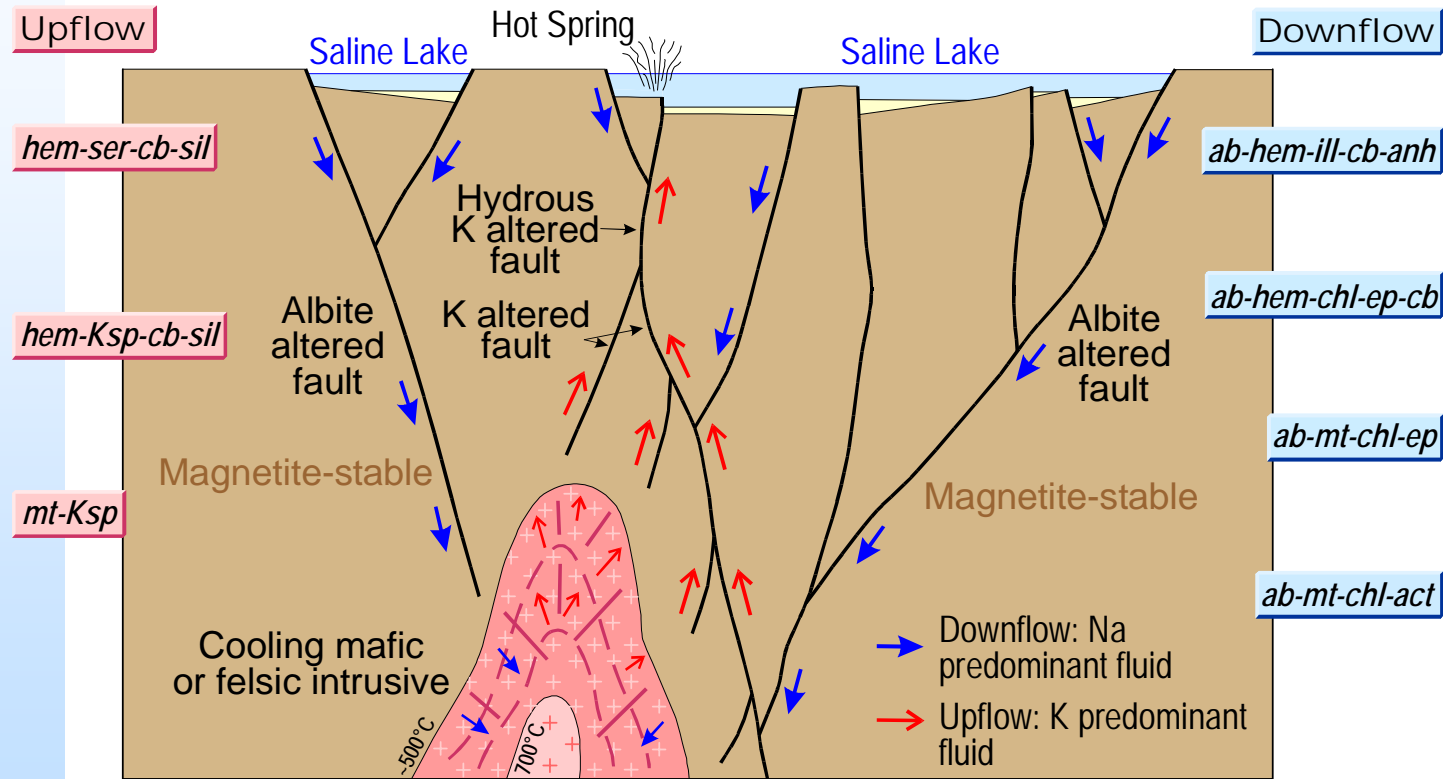


Yoeval Area, N
Lachlan Fold Belt:
Magnetite-
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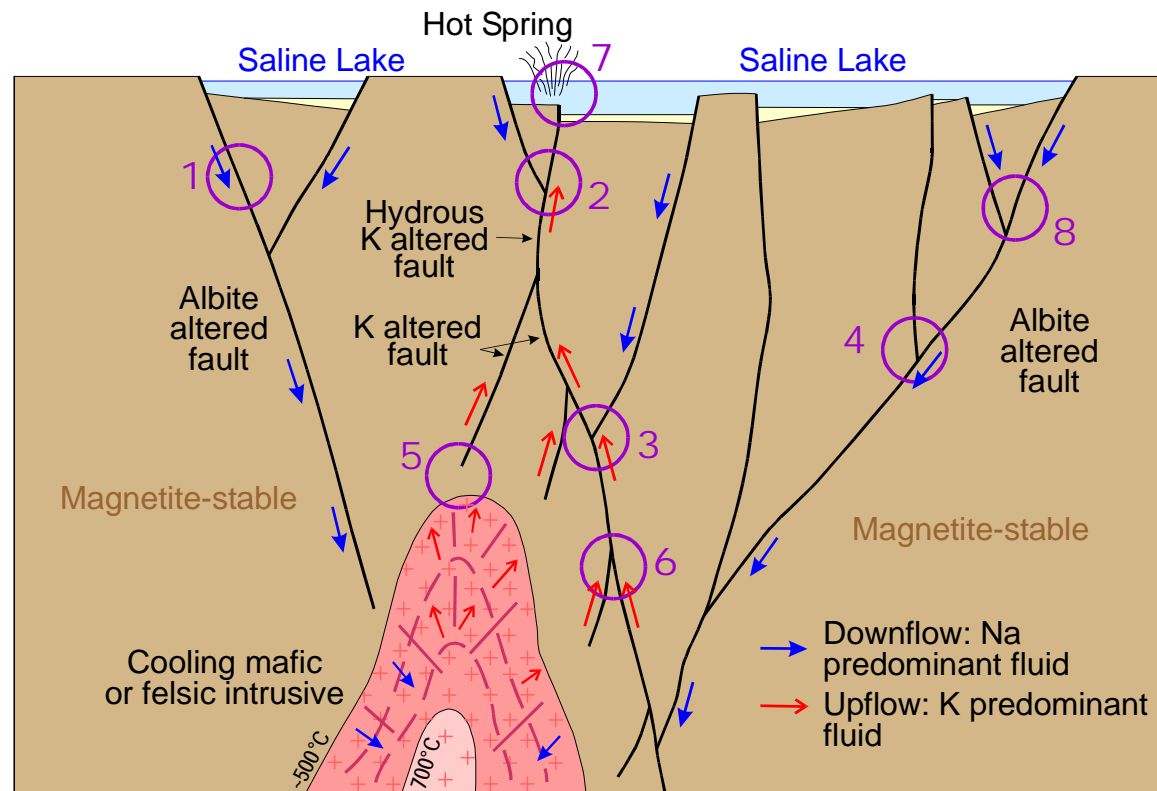






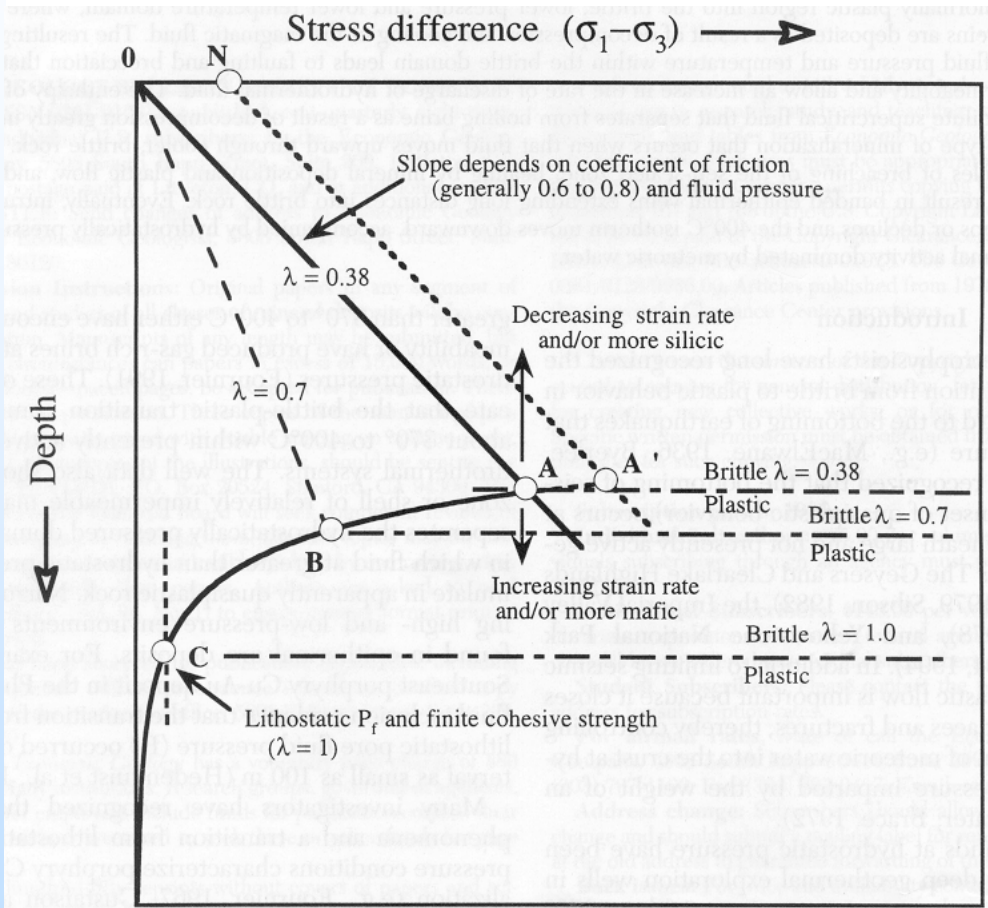
Intracratonic Transtensional Setting





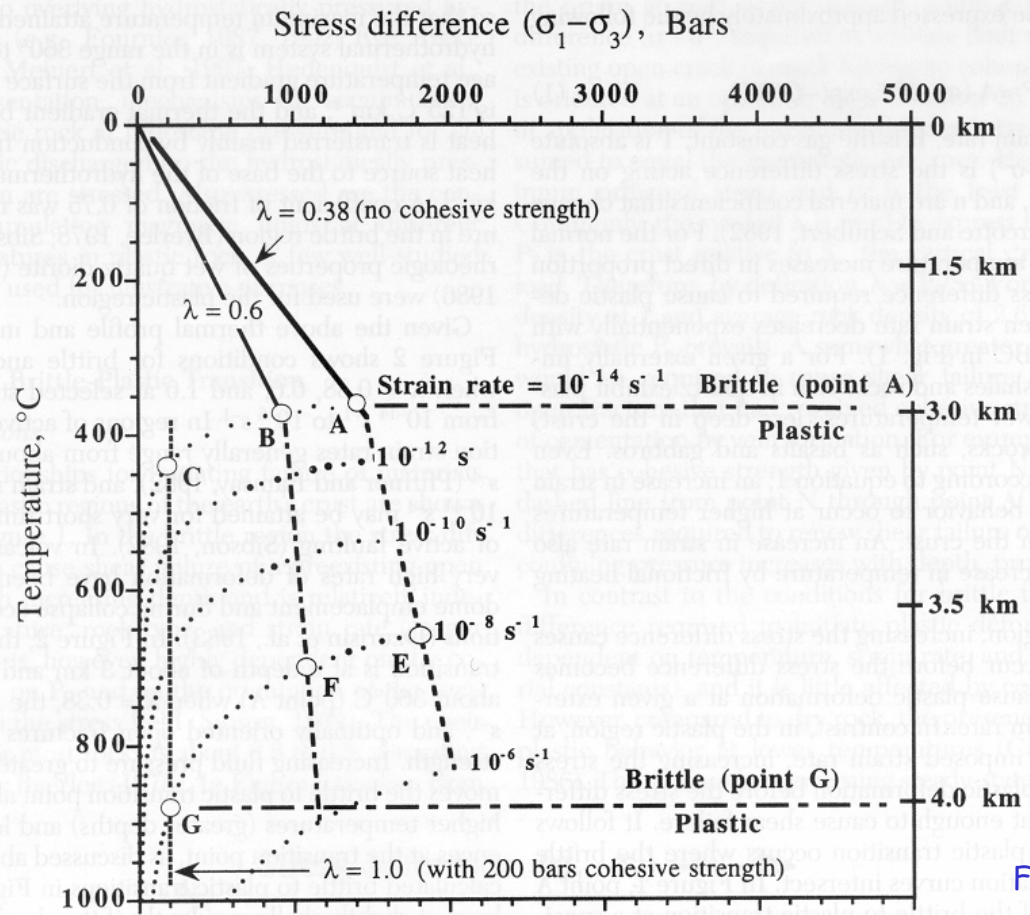
- 1, 8 Mantos Blancos
- 2 Hem-ser rich "cooler" Ernest Henry
- 3 Ernest Henry, La Candelaria, Salobo
- 4 Starra
- 5, 6 Barren mt-act - Ksp
- 7 Mnox-hem-cl-sil - "exhalite"





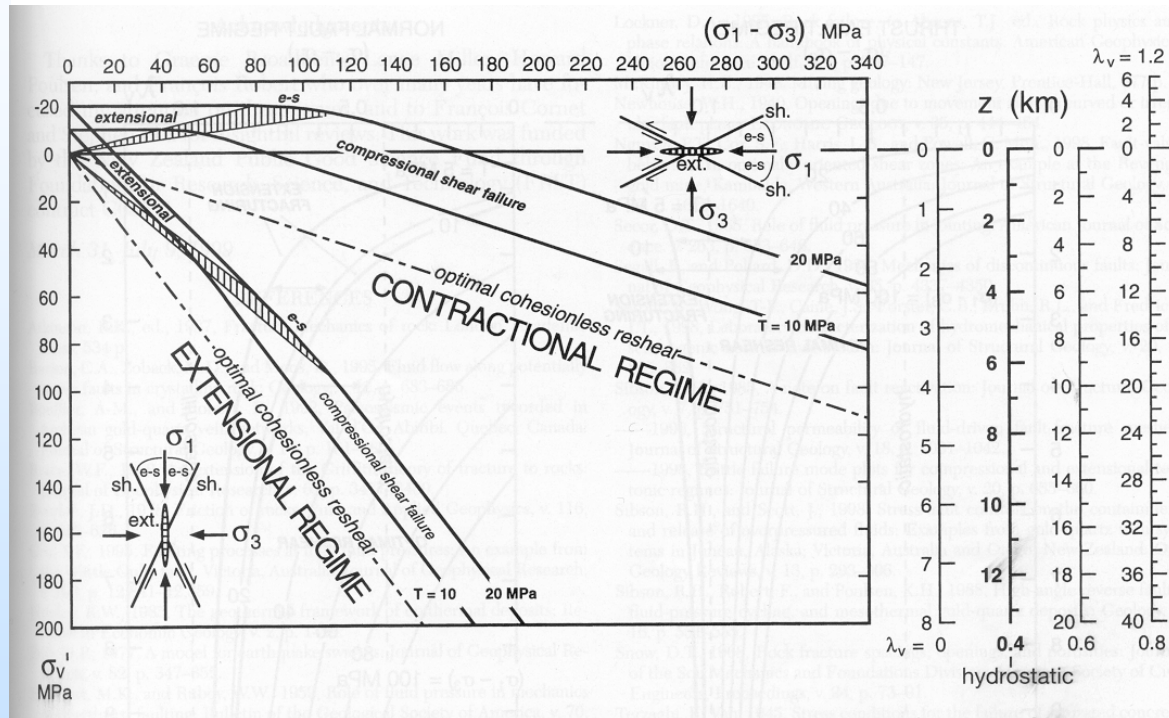
Fournier, 1999





Fournier, 1999



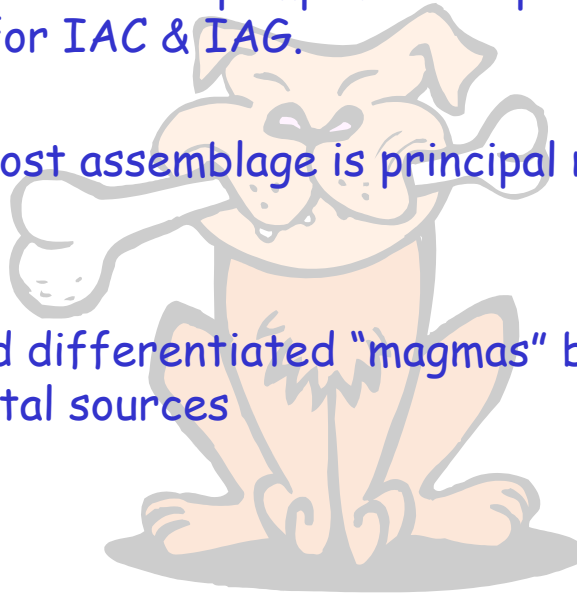


Sibson, 2000



Conclusion

- "Magma" is the heat pump & and is principal metal source for IAC & IAG.
- "Magma" host assemblage is principal metal source for IOCG
- Hotter and differentiated "magmas" better heat pumps and better metal sources



Conclusion

- Regional scale contractional faults provide much if not most of the "water".
- Host assemblage of magma largely constrains fO_2 , ΣSO_4 , and hence metal ratios in resulting ore deposit
- "Magma" initially constrains fO_2 , pH, ΣSO_4 , .. then injected water "takes over" with increase in W/R
- Ore deposit where magma intersects a contractional fault in a stress regime that causes injection of "water" from the fault zone at ~ 5 to 10km depth

Notes Added: Post Symposium

- Regional scale contractional faults must also inject "water" into magma in the suprasolidus state as well.. ..
- This "water" either adds methane/reduced sulphur or oxidised sulphur, as sulphate, to the magma or hot rock.. ..
- Magmas are not fertile if they are not "juiced up" by the fluid reservoir in the contractional fault.. ..
- Metallogeny of magma dependent on $fO_2/\Sigma SO_4/\Sigma HS$ in the fluid injected into the melt... & hence redox of host lithological succession
- Largely suprasolidus mineralisation if fluids injected suprasolidus, mineralisation largely subsolidus if fluids injected subsolidus. Latter scenario generates bigger & better deposits

