Rock Magnetism and Magnetic Fabric Analysis of Fault Produced Pseudotachylytes and Adjacent Host-rocks from the Mesoproterozoic Albany-Fraser Orogenic Belt, Cape Arid Region, Southwest Australia

By

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Fault rocks: Pseudotachylytes (fossil earthquakes)

- Narrow zones of crushed rocks along which two blocks moved
- Movement could be either as unstable, fast movement (brittle fault) or stable, slow sliding (ductile fault)
- Brittle-ductile transition zone often associated with frictional melt due to rapid rise in temperature (~ >1000°C) during seismic slip
- Fault-produced cryptocrystalline to glassy-textured rocks called pseudotachylytes and considered as "fossil earthquake"
- May hold important information regarding the assembly of tectonic units and may provide improved insight into the generation of earthquakes and the process of seismic rupture

Sketch illustrating the occurrence of diverse fault rocks at different depths (from Yang et al., 2020).
Faulting-related Physical and Chemical Processes

Preexisting grains may crush to finer grains due to comminution, and may enhance magnetic susceptibility without increasing the overall magnetic grains.

Frictional melting may release iron and with rapid, quench cooling may form new magnetite grains, whereas extreme reducing conditions may form metallic iron.

Infiltration and percolation of meteoric water may dissolve iron bearing minerals or bring external free iron and may induce precipitation of new magnetic minerals.

Low temperature oxidation of magnetite may form maghemite.

Conceptual model showing the faulting-related physical and chemical processes during the different stages of the seismic cycle (modified from Yang et al., 2020).
Study area: Albany–Fraser Orogenic Belt (AFO):

- Exposed along the southern coast of Western Australia
- Formed due to the continental collision and suturing of West Australian Craton and the Mawson Craton
- Records the tectonic evolution of Rodinia assembly (~1300 – 1100 Ma)
- Characterized by intense deformation, polyphase metamorphism, and emplacement of plutonic rocks

From Fitzsimons and Buchan, 2005
Generalized Geologic Map of AFO belt and field location:

Ca. 1200 - 1100 Ma
Granite

Ca. 1300 Ma
Heterogeneous granitoid gneiss

Ca. 1300 Ma
Granite

Ca. 1550 Ma
Phyllite, schist

Ca. 1550 Ma
Quartzite, schist, banded iron-formation

Ca. 1700 - 1300 Ma
Granitoid gneiss

Ca. 1700 - 1600 Ma
Granitoid gneiss

Ca. 2630 Ma
Granitoid gneiss

Ca. 3000 - 2460 Ma
Mafic igneous rock

Ca. 2690 - 2550 Ma
Granite, granitoid, tonalite

Albany—Fraser Orogen
ca. 1300 - 1100 Ma
Pseudotachylyte Veins in the AFO

Field Recognition:

- Cross-cut relationships
- Sharp layer boundaries
- Presence of injection veins
- Host-rock derived survivor clasts
- Ultra-fine grain polymineralic assemblage
Research Objectives:

Physiochemical conditions and fault-kinematics to contribute information regarding the complex tectonic evolution of the Mid-Proterozoic Albany–Fraser Orogenic Belt by documenting the-

- Mineralogical and microstructural properties; and the rock magnetic/paleomagnetic characteristics of fault rocks and surrounding host rocks

- Magnetofabric analysis to evaluate the flow-direction of the frictional melt and to infer the regional maximum stress direction

- Determining the slip-sense which has been difficult from the outcrop relations

- Paleomagnetic data to constraint the age of formation of the pseudotachylytes vein rocks