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Macro to Micro-scale investigation of the Heyuan Fault and Giant Quartz Reef – a Geothermal Prospect

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This study investigates the Heyuan fault, South China as a potential deep geothermal target.
The present-day abundance of hot springs and the manifestation of a giant quartz reef structure along the length of the fault signify a unique, long-lived process.

The Heyuan fault gives us the opportunity to study a giant quartz reef in a present day geothermally-active fault zone. Analyses of the quartz reef, which serves as a proxy for the deeper fluid circulation, can be compared directly against an assessment of the current fluid flow regime supplying the hot springs. Understanding the fluid flow regime and dynamic permeability (temporally and distally across the fault zone) in relation to interacting faults, and changing stress fields, is of key importance to understanding geothermal fault zones as reservoirs.

Macro-scale investigation provides the structural overview of the fault intersection relationship and the associated fracture networks in the fault zone resulting from these faults and the changing stress regime. From this we see an evolution from low-angle, sealed fractures associated with normal faulting, to sub-vertical, open fractures related to the influence of strike-slip faults which cross-cut the Heyuan fault.

The micro-structural analysis will provide key insight into the formation of massive quartz reef systems found along sections of the Heyuan Fault. This includes invaluable information on the genesis, transport and precipitation of hydrothermal material which creates these reefs, as well as the timing of events and repeated seismic and creep activity. This analysis has so far identified multiple cyclical stages of ductile creep and embrittlement, indicating a potential seismic-interseismic relationship between fluid flow and quartz precipitation. Understanding all of these aspects is crucial to unravelling how this hydrothermal fluid is transported from the subsurface via fault and fracture networks which act to control the fluid pathways.

Combining the results of the macro and micro-scale structural analyses, we hypothesise that i) deep fluids were able to percolate up along the fault, precipitated over time to build the quartz reef ii) A change in stress regime led to compression of the fault and inability of fluids to channel upward, thus trapping fluids beneath the quartz reef, effectively acting as a seal, iii) the influence of later strike-slip faults cross-cutting the Heyuan fault generate a sub-vertical fracture network, permeating the quartz reef seal and allowing the fluid to channel upwards to feed the present day hot springs.

Additional in-depth micro-scale investigation currently being carried out, e.g. microstructural and fluid inclusions, looks to further support this notion.