# Origin of sulfur in active epithermal gold-depositing systems

Isabelle Chambefort[1]

[1]GNS Science, Wairakei Research Centre, New Zealand
i.chambefort@gns.cri.nz

Sulfur is a key component in hydrothermal systems forming arc-related ore deposits. The Taupo Volcanic Zone is an actively rifting arc characterized by thin crust (15-20 km) and voluminous rhyolitic magmatism with minor basalt and andesite. TVZ active geothermal systems are generally considered as the equivalent of low-sulfidation epithermal Au (hydrothermal) systems [1]. The majority of the sulfur species near the surface and in the reservoir ($H_2S_g$, $H_2S_{aq}$, $HSO_{4-aq}$, shallow sulfate, elemental sulfur) are the result of quantitative oxidation of deep-sourced $H_2S$ near the surface by oxygen in the atmosphere and meteoric fluid. $\delta^{34}S(H_2S_g)$ is constant through the TVZ and ranges between 4 and 6‰, and is assumed to be linked to deep basalt degassing and buffering by the greywacke basement [2]. In contrast sulfate-sulfur in solution varies strongly due to surface processes, however, sulfate-oxygen is in equilibrium with meteoric water ($\delta^{18}O$ ($HSO_4^-$) ≈ -1‰).

This work aims to characterize the deep sulfur species, and constrain possible variations in the source magmatic $H_2S/SO_2$ ratio. As different types of magmas are intruding the shallow crust underneath the arc, e.g. basalt, andesite, rhyolite, these are expected to have different sulfur saturation and oxidation states, and thus different input of sulfur in the exsolving fluids.

Deep (>2km) high-temperature (~300°C) anhydrite and pyrite as well as gas and liquid from wells were sampled in two fields. Isotopic values of sulfates show 3 end members, with exchange trend between them: 1) deep hypogene sulfate ($\delta^{18}O_{anh}$ ≈ 2‰, $\delta^{34}S_{anh}$ ≈ 22‰) in equilibrium with magmatic $H_2S$ where $H_2S/SO_2$ >> 1, which is quantitatively oxidized to produce 2) lighter sulfate ($\delta^{18}O_{anh}$ ≈ 2‰, $\delta^{34}S_{anh}$ ≈ 0‰) and 3) deep sulfate with heavy oxygen and sulfur ($\delta^{18}O_{anh}$ ≈ 17‰, $\delta^{34}S_{anh}$ ≈ 14‰). The latter sulfate is interpreted to be produced by $SO_2$ disproportionation at depth (from magmatic fluid with $H_2S/SO_2$ ratio ≈ 1) and is in equilibrium with pyrite,, similar to sulfates observed in high-sulfidation gold ore systems. Relict of $SO_2$ degassing at depth allow us to discuss further the origin of metals in the low-sulfidation systems.

[1] Simmons and Brown, 1997, *Geology*, **35**, 1099-1102 [2] Robinson, B.W. 1987. *IAEA*, Vienna.