

Fluid origins in orogenic Au mineralization defined by noble gas-halogen systematics, Alpine & Otago Schists, New Zealand

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Orogenic gold mineralization is a ubiquitous feature of the world's regional metamorphic terranes and is economically significant on a global scale. Despite their importance, the origins of fluids and gold remain enigmatic with potentially complex fluid histories comprising mixing and unmixing processes. Noble gases are well-known conservative tracers of crustal fluid sources. We present a combined study of noble gas-halogen systematics focussing on the Pliocene-Recent mineralization associated with the present hydrothermal regime of the Southern Alps, and the economic Mesozoic deposits of the Otago Schists.

³He/⁴He ratios confirm the absence of mantle derived fluids, simplifying potential fluid sources. All samples show simple two component mixing between a saline, high ⁴⁰Ar/³⁶Ar (500-5000) crustal fluid, and a less saline fluid of atmospheric ⁴⁰Ar/³⁶Ar composition approximating to meteoric water. Neon, krypton and xenon isotope ratios are atmospheric in composition. Fractionated elemental noble gas ratios show evidence of unmixing (boiling?), though high ⁴⁰Ar concentrations are confirmed to originate from fluid inclusions by a correlation between ⁴⁰Ar/³⁶Ar and Cl/³⁶Ar. Fluid inclusion salinities determined by microthermometry are higher than from Cl/³⁶Ar assuming ASW, providing further evidence of unmixing. Combining microthermometry salinities with simultaneously released halogens and noble gases permits determination of noble gas concentrations in water. This provides quantitative constraints on fluid processes. ⁴⁰Ar/³⁶Ar ratios are lower in the Mesozoic deposits than in younger Alpine samples, suggesting a more immature metamorphic setting or re-setting of the fluid in the older deposits. Br/Cl and I/Cl are unaffected by boiling and show a clear crustal source in both systems. Excess I sourced from organic sediments is more prevalent in economic Mesozoic samples and consistent with excess sedimentary derived Xe. I-noble gas systematics may have the potential to distinguish between fertile and depleted source rock systems.

U-Pb systematics of the Acapulco meteorite: Primordial and recently mobilized Pb

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U/Pb systematics were measured in separated mineral phases and in bulk fractions of the Acapulco meteorite. This undifferentiated meteorite, exhibits unusual high abundances of U and Th and it was proposed that the main part of these elements was brought early to the Acapulco precursor by a low temperature melt [1]. We support this idea and suggest that the melt has selectively extracted U, Th and LREEs from phosphates. Subsequently these elements were incorporated into Acapulco and associated to the formation of apatite. The interaction with this Cl and F rich melt could have been triggered by an early impact on the Acapulco parent body. The unusual low Th/U ratio of bulk Acapulco, ~ 1, is the result of this melting event, it is dated by the U/Pb system and occurred between 4.562 Ga and 4.556 Ga.

Because of its low ²³⁸U/²⁰⁴Pb ratio, the Acapulco feldspar has frozen the Pb composition that formed 4.556 Ga ago. This Pb composition lies close to the primordial Pb that has been defined on iron meteorites [2, 3]. The small difference between the primordial Pb composition and the feldspar composition can be explained by a chronological evolution that occurred between 4.567 and 4.556 Ga.

U/Pb equilibration in Acapulco ceased at 4.5558 ± 0.0006 Ga. Under the condition that the cooling of the Acapulco parent body occurred slowly at this time, the age indicates when Acapulco reached 550°C, the closure temperature of the U/Pb system in apatite. However, based on the similarity between Pb/Pb and Ar/Ar ages, it also has been proposed that the cooling might have occurred more rapidly [4]. In this framework, we suggest that the break-up of the Acapulco parent body occurred before 4.556 Ga and after 4.564 Ga, the 'absolute' age of the Hf/W closure in acapulcoites [5].

Acapulco bulk shows an excess of radiogenic Pb that has been recently added. We consider that contamination by modern terrestrial Pb cannot explain this excess and propose instead that this Pb was added 6 Ma ago, when Acapulco was excavated from its parent body.

- [1] Zipfel *et al.* (1995) *Geochim. Cosmochim. Acta* **59**, 3607-3627. [2] Tatsumoto *et al.* (1973) *Science* **180**, 1279-1283. [3] Göpel *et al.* (1985) *Geochim. Cosmochim. Acta* **49**, 1681-1695. [4] Renne (2000) *Earth Planet. Sci. Lett.* **175**, 13-26. [5] Touboul *et al.* *Lunar Planet. Sci. Conf. XXXIIX*, Lunar Planet. Inst., Houston, #2317 (abstr).