Magmatic Br/Cl - I/Cl : Possible implications for bulk earth and seawater composition through time

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'I-type' Granites

Molar Br/Cl (~1-2×10^{-3}) and I/Cl (~10-40×10^{-6}) values determined for Porphyry Copper Deposit fluid inclusions [1,2] are similar to the range determined from mantle diamond and Br/Cl in seawater plus MORB [3,4]. This is consistent with mantle buffering of modern seawater (Br/Cl = 1.54×10^{-3}) [2] and Br/Cl plus I/Cl of magmatic fluids evolved from supra-subduction zone I-type intrusions[1,2].

'A-type' Granites

Data from the Proterozoic Ernest Henry Fe oxide-Cu-Au deposit, Mt Isa Inlier, indicate 1) a crustal fluid ($^{40}Ar/^{36}Ar$ <2,000) and 2) a magmatic fluid ($^{40}Ar/^{36}Ar$ ~29,000) probably sourced from regionally extensive A-type granites. The magmatic fluid has mantle-like Br/Cl, but I/Cl (~11×10^{-6}) at the lower limit determined for PCD or diamond [1,2,4].

If the halogens originated in mantle-derived magma source rocks, these data suggest mantle Br/Cl has been constant since 1.6-2.2 Ga: Ancient and modern seawater would therefore have had similar Br/Cl values, within the limits defined for the mantle. Lower I/Cl values may reflect less efficient recycling of less abundant I-rich organic sediments at Paleoproterozoic subduction zones, or A-type magma generation outside subduction-related magmatic arcs.

Further work on primary magmatic fluid inclusions will improve constraint on Proterozoic and Archaean halogen systematics and test our assertion of uniform seawater Br/Cl.

'S-type' Granites

The Cornubian Batholith has lower than mantle/seawater Br/Cl (0.45-0.89×10^{-3}) [2,5] and higher I/Cl values (~50-110×10^{-6}) [2], possibly reflecting the involvement of sedimentary rocks in crustal anatexis [2].

Evaporitic rocks and organic sediments enrich the continental crust in Cl and I, relative to bulk earth. Sedimentary formation waters with a dominantly bittern origin are Br-enriched relative to seawater (+/- the mantle). They are driven off prior to anatexis, suggesting a majority of S-type granites could be characterised by lower than mantle Br/Cl. Lost, 'bittern brine Br' could contribute toward underestimation of mean continental crust Br/Cl values.

References

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