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Magmatic and tectonic construction of Archaean crust: new relevance of the terrestrial iron-core-forming process and Phanerozoic subduction mechanisms.

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This contribution brings together my studies from opposite ends of the terrestrial age range and discusses their relevance to Archaean crustal genesis, building upon an earlier proposal (Osmaston 1992a).

At the far end, building iron cores in all the terrestrial planets by two-stage accretion or by percolation both face serious difficulties. An alternative is to react magmatic FeO with a reducing nebular atmosphere at the surface of a vigorously convecting protoplanet, to give Fe/FeS plus a hydrated crust, and then to 'subduct' them. This gives the early Earth a substantially wet mantle, with two consequences. Firstly, mantle viscosity is reduced by 1-2 orders of magnitude, giving ample ability to extract the early-Earth heat production. Secondly, komatiites were produced from a relatively wet mantle, evidenced by the constant association of felsics with them, by occurrences of komatiitic tuffs, by Nb anomalies and by S- and H2O-borne rich mineralizations (syn-eruptive segregation?). So Archaean greenstone belts may escape the subduction connotation and start their lives as MOR-equivalents.

At the near end of geological time, study of Phanerozoic subduction, including circum-Pacific histories and activity, shows the action of two major processes: subduction tectonic erosion (STE) and post-subduction magmatism (PSM), inaccurately called post-collision magmatism. In STE mechanical action at plate downbends removes material from the hanging wall and rapidly undercuts the margin by many hundred kilometres, rendering it liable to imbrication. The essential part played by pre-collision STE in construction of the Alps has been outlined (Osmaston, 1997). PSM (Osmaston, 1992a) is silicic-granitoid, lasts for up to 40Ma, and is attributed to wholesale melting of subduction interface crustal material by heat that has soaked upward through the former slab. A diagnostic 'oceanward' migration ("sweepback") of magmatic onset is often seen.

Where data are available, both STE and PSM were confined to where the subducting plate was young (<70Ma), which makes both processes highly likely in the Archaean. Central to my Alps synthesis, based on studies elsewhere (Osmaston, 1992b), was the recognition that subduction commonly begins within the oceanic domain, later reaching the continental margin by STE and imbrication. I propose that Archaean greenstone belts were originally passive margin oceanic crust that thus became part of an extensive subduction-undercut margin. TTG intrusion is seen as PSM when subduction was halted, perhaps by arrival of a micro-craton. These features will be discussed briefly by reference to the ~3.3Ga Barberton and 2.7Ga western Superior areas.

This interpretation implies that the late Archaean acceleration in TTG/greenstone belt addition to cratons represents an increasing frequency of interruption of subduction. Each such PSM event advected mantle heat to the surface that would otherwise have been returned to the mantle. The increasing greenstone/MOR-crest water depths in the late Archaean suggest a cooling mantle.

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