The Cihai diabase in the Beishan region, NW China: Isotope geochronology, geochemistry and implications for Cornwall-style iron mineralization

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Diabase dykes in Cihai, Beishan region, NW China are spatially and temporally associated with 'Cornwall-type' iron deposits. U-Pb dating of zircons from a diabase dyke using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) yields an age of 128.5±0.3 Ma. Most of the diabases show low Mg-numbers, suggesting evolved magmas. The diabase dykes show typical ophitic or sub-ophitic textures, and are dominantly composed of phenocrysts of plagioclase and clinopyroxene, with minor and varying amounts of biotite and hornblende, and minor disseminated magnetite. The diabase dykes are characterized by minor variation in SiO_2 (44.67-49.76 wt.%) and MnO (0.14-0.26 wt.%), but show a marked range of Al_2O_3 (10.66-14.21 wt.%), total Fe_2O_3 (9.52-13.88 wt.%), TiO_2 (0.66-2.82 wt.%) and relatively high MgO (4.87-9.29 wt.%) with an Mg# value [atomic $Mg/(Mg+Fe^{2+})$] of up to 66. The Cihai diabases possibly experienced fractional crystallization of olivine + clinopyroxene and minor crustal contamination during the differentiation process. Prominent negative Nb, Ta and Ti anomalies suggest derivation from subduction-modified mantle. Furthermore, the rocks have relatively unradiogenic Sr- and Nd-isotopic ratios. These characteristics probably reflect partial melting of a subduction component in the source mantle lithosphere through heat input from an upwelling asthenospheric mantle. Such processes probably occurred within an extensional setting during the Early Cretaceous in the Beishan area. The iron-rich fluids were derived from deep sources, and the iron ores were concentrated through a convection cell driven by temperature gradients established by the intrusion of the diabase sills. The combined processes of subduction-related enrichment in the source, shallow depth of emplacement, and the involvement of large-scale circulation of basinal brines from an evaporitic source are inferred to have contributed to the formation of the 'Cornwall-type' mineralization in Cihai.

Challenges in constraining and understanding Strombolian volcanism

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Activity at Stromboli is exceptionally well characterised on most time scales but it remains a challenge to identify what portion of that activity should be defined as “Strombolian’ in the strict sense of naming the eruption style, in a fashion that is useful elsewhere. Here we look at delineating the limits of ‘Strombolian style’, particularly in the context of demarcation from Hawaiian fountaining eruptions.

That demarcation has generally been articulated in terms of transient versus sustained activity linked to mechanical decoupling versus partial coupling of exsolved volatiles. However, while sustained fountains are steady, they are seldom steady, and violent Strombolian events can last for minutes.

Plotting basaltic activity in viscosity-mass eruption rate space reveals some of the issues. Individual Strombolian explosions occupy the short duration, low eruption rate corner of such a plot, very clearly distinguished from high Hawaiian fountains that have durations that are 3 to 5 orders of magnitude longer and mass discharge rates that are 10 to 100 times larger. However the spectrum of activity called names such as ‘low fountains’, ‘gas pistoning’ and ‘violent Strombolian’ defines a grey scale between these extremes. Finally on what time scale can we define a Strombolian (or Hawaiian) ‘eruption”, i.e., what is the most characteristic time scale - a transient explosion of seconds duration or centuries of continual but varied activity?

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