Enigmatic voluminous andesite magmatism at Glencoe caldera volcano, SW Scottish Highlands

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The 'Late' Caledonian high-K calc-alkaline magmatism of northern Britain and Ireland is problematic in that it records an intense lithospheric thermal anomaly that seemingly peaked subsequent to ocean closure and attendant subduction. Pulsed bimodal intermediate and silicic magmas characterise the province, which includes Glencoe caldera volcano. Our project builds upon the work of Thirlwall [1], (1) to refine understanding of the origin of the voluminous intermediate magmas and their role(s) in crustal melting, and (2) to constrain precisely the timing and duration of this intense magmatic episode, by U-Pb zircon dating. We aim to test the hypothesis of Atherton and Ghani [2] that the thermal anomaly resulted from slab-breakoff. Repetitive voluminous andesite magmatism is characteristic of the Glencoe caldera volcano, with the ascent of magmas facilitated by active extension or transtension across crust-penetrating fractures or shear zones. Full reappraisal of Glencoe caldera volcano (Kokelaar & Moore [3]), together with our detailed petrogenetic and stratigraphic studies, reveals that the Bidean nam Bian Andesites (BnB) record unusually rapid and voluminous effusion of low-viscosity (hot) andesite and dacite lavas. Geochemical data from the BnB, when constrained both temporally and spatially, reveal that this single eruptive unit has a minimum volume of 12km^3 comprising two discrete magmas that erupted simultaneously. Physically and geochemically the high-K calc-alkaline andesites and dacites of Glencoe are unlike common orogenic magmas that involve substantial residence at shallow crustal levels. Rather, our data, along with those of Thirlwall[1], indicate that Glencoe was centred above a deep 'hot zone' (e.g. Annen & Sparks [4]), where andesitic magmas evolved from trapped lithospheric mantle melts and were associated with substantial crustal melting. Future isotope studies will investigate the roles of 'hot zone' fractional crystallisation and crustal addition.

References

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Late Mesozoic adakites from the northeastern China: Evidence for subduction of the Paleo-Pacific Ocean toward the NE Asian continent

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It has been long debated about the time and effect of Mesozoic subduction of the Paleo-Pacific Ocean plate on the tectonic evolution of the East Asian continental margin. This is mostly hampered by the paucity of contemporaneous subduction-related magmas that can provide reliable evidence to confirm the subduction of oceanic slabs, although paleomagnetic data suggested that the Pacific Oceanic Plate began to move in a NNW direction toward the East Asian continent at ca. 125 Ma.

Late Mesozoic adakites discovered from the Yanji area in the NE China provide evidence for their derivation from the subducted oceanic slab and strong interaction with the wall peridotites during magma ascent. These rocks span a SiO_2 range of 60.7-62.5% and a MgO range of 3.36-4.24% with a Mg# (Mg# =100×Mg/(Mg+Fe) in atomic ratio) range pf 65-71. Such features as high Sr (1378-3529 ppm) and Cr (84-161 ppm) and Ni (76-117 ppm), low Y (7.1-11.0 ppm) and HREE (e.g., Yb = 0.49-1.01 ppm) are typical of modern adakites from the globe. The adakites have strongly depleted Sr ($^{87}Sr/^{86}Sr_i$ =0.7032-0.7034) and moderately radiogenic Nd ($\varepsilon_{Nd}(t)$ = + 0.5 ~ + 5.8) and Pb isotopic compositions ($^{206}Pb/^{204}Pb_i$ = 17.87 - 18.00; $^{207}Pb/^{204}Pb_i$ = 15.47 - 15.52; $^{208}Pb/^{204}Pb_i$ = 37.59 - 37.85). The slightly higher Sr but lower Nd and Pb isotopic compositions than the Cenozoic Aleutian adakites suggest the involvement of continental lower-middle crust (e.g., the lower crust from the Sino-Korean Craton, which has extremely low Pb and Nd but high Sr isotopic ratio) in petrogenesis. Combined major, trace element and Sr-Nd-Pb isotope data of the late Mesozoic adakites from the NE China indicate that they were derived from a subducted oceanic slab under the eclogite-facies metamorphic conditions and experienced intensive interaction with peridotites in accordance with high Mg# and Cr and Ni. An oblique subduction of the Paleo-Pacific Ocean underneath the NE Asian continent thus might play an important role in the formation of the NE- to NNE- directional structural lineation, lithospheric extension and extrusion of calc-alkaline to high-K calc-alkaline magmas along the NE Asian continental margin during late Mesozoic time.