Arc lithosphere imposes segmented, great circle volcano distribution in the central Sunda Arc, Indonesia

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The term island arc betrays the common assumption that subduction zone magmatism occurs in curved zones, which can be expressed by approximating arcs as segments of small circles on a spherical surface. Such observations are used to relate arc volcano locations to their vertical separation from seismicity in the subducted slab and to conclude that the primary control on loci of magmatism lies in the slab or mantle wedge.

The small circle approximation ignores longstanding, empirical observations that magmatic centres in many subduction systems describe linear features i.e. segments of great circles. The Sunda Arc, Indonesia, is one system that has proved difficult to accommodate in small circle models. We applied an objective line-fitting protocol; Hough Transform image analysis, to explore the distribution of central Sunda Arc volcanoes. This shows that volcano distribution in the central Sunda Arc is best described as en echelon, great circle segments each of 500 – 750km length, rather than as small circles.

Central Sunda Arc segmentation reflects weakness of the arc lithosphere resulting from tectonic forces generated close to the plate margin and/or by arc lithosphere flexure. To the east of our study area the arc has collided with Australian continental crust while highly oblique convergence to the west has produced the Great Sumatran Fault. In both cases volcano locations can be related to stress imposed upon the arc lithosphere by these specific features. Furthermore, changing locations, petrography and geochemistry of central Sunda magmatism since the late-Pliocene can also be attributed to evolving stress in the upper plate.

We conclude that the arc lithosphere stress field is the primary control on distribution of Sunda Arc volcanoes. Interplay between this stress field and the arc crust will provide a major control upon pathways of magma from the mantle wedge to the surface.

Micro-Chronology of the Earliest Solar System: Challenges for the Future

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During the first ~1-2 Ma of our Solar System's history, as the Sun evolved from a Class 0 to a Class II protostar, solid matter in the innermost disk was heated, evaporated and recondensed, and extensively reprocessed (including melting). Such solids are preserved in chondrites as calcium-aluminum-rich inclusions (CAIs) and amoeboid olivine aggregates (AOAs). Evidence for the original evaporation and condensation is preserved mainly in the form of characteristic chemical and isotopic signatures, but rarely in the physical properties (e.g. textures) of the objects. In contrast, evidence for repeated melting and re-heating is everywhere in the petrology of most CAIs and AOAs. Advances in the analytical precision of mass spectrometry (MS), especially secondary ionization (SIMS), thermal ionization (TIMS), and inductively-coupled plasma (ICP-MS), now permit extraordinary time resolution of early solar system events that are recorded in the petrologic properties of CAIs and AOAs. Pb-Pb ages of CAIs yield a precision of < 500 Ka. ICP-MS measurements of the ^{26}Mg-^{26}Al isotope system demonstrate that the primary fractionation (presumably via condensation) of Al from Mg took place within 20 Ka. SIMS determinations of internal ^{26}Mg-^{26}Al extinct isochrons confirm that CAI precursors formed within a very short time consistent with that determined by ICP-MS, but remelting and reprocessing of CAIs continued for at least 200 Ka and possibly as long as 600 Ka. The time resolution of such SIMS internal isochrons is now bettter than 50 Ka. The challenge now is to identify the nature of the processes that are recorded in this chronology. For example, the original fractionation event that made the CAI precursors apparently was singular and of short duration whereas remelting occurred as a result of a process that happened repeatedly over 200 Ka or more. Nor is it clear if the formation of Wark-Lovering rims was a singular event affecting all CAIs simultaneously or a repeating event over time. Finally, there is as yet no anchor that ties Solar chronology with CAI chronology. One recent suggestion is that the last (or nearly so) FU-Orionis flare in the early Sun was responsible for making the generation of CAIs we now see, but earlier generations were destroyed. Such linking of solar processes and chronology with nebular products is a major challenge for the future.

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