Deep sediment melts contribute to Southwest Japan adakitic magmas

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The Quaternary Southwest Japan Arc is a product of subduction of the hot, young Philippine Sea Plate beneath the Eurasian Continental Plate. The magmas erupted from the Southwest Japan Arc belong to a category of magmas commonly referred to as "adakites". These magmas show trace element evidence for interaction with garnet at depth, and may be associated with partial melting of subducted altered oceanic crust. Also found throughout the southern Sea of Japan and scattered across Southwestern Japan, Korea, and China are alkali basalts with little apparent connection to the subduction zone. We have determined major element, trace element, and Sr, Nd, Pb, and U-Th isotopic compositions for a bimodal suite of lavas erupted at the Daisen volcanic field in the Southwest Japan Arc. These magmas consist of mildly alkaline basalts and a calcalkaline intermediate suite, separated by a ~10 wt. % silica gap. Our data suggest that the basalts are not parental to the intermediate magmas, and contain a small contribution of EM1-like mantle common in Sea of Japan alkali basalts but not apparent in the Daisen intermediate magmas. The intermediate magmas show trace element and isotopic evidence for interaction with garnet, but unlike other adakitic magmas, they show strong trace element and isotopic evidence for incorporation of significant (~25%) partial melt of subducted sediment. Recent studies [1] suggest that the ~350m sediment blanket subducted beneath Southwest Japan (Nankai) may become detached from the slab at temperatures between 650-675˚C. The implications of sediment detachment are two-fold: 1) the removal of the insulating sedimentary cover would enable rapid heating of the basaltic slab surface, encouraging slab melting, and 2) the detached sediments may be relaminated at the base of the arc crust [2], where they could contribute partial melts to the slab-derived magma prior to eruption. The uncharacteristically high Al_2O_3 (17-18%) and low MgO (~2%) contents of the Daisen adakites are consistent with assimilation of significant sediment partial melts derived from depths >30km at the base of the arc crust.

[1] Behn *et al*, *Nature Geosci*. 4 (2011) 641-646. [2] Hacker *et al*, *Earth Planet. Sci. Lett*. 307 (2011) 501-516

Low-dimensional models of complex aerosol-cloud interactions

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The radiative forcing associated with aerosol-cloud interactions persists to be one of the largest unknowns of the climate system. To address this problem, both the aerosol and cloud communities have focused on process-level understanding of smaller components of the aerosol-cloud system. While this approach has yielded major advances in the understanding of both aerosol and cloud physics, we have been less successful at addressing the effects of aerosol perturbations on cloud systems, in which constant adjustments (feedbacks) can occur. The problem is exacerbated by the complexity of the adjustments, and the fact that they occur at a large range of spatiotemporal scales. Currently no climate model is able to address the full range of relevant scales and the processes are difficult to constrain with observations.

In this overview we will look at the aerosol-cloud system as a dynamical, self-adjusting entity and attempt to address the question of the resilience of the system to aerosol perturbation. To do so we will use a combination of observations, detailed process-modeling, and low-dimensional models that capture the essence of the system [1]. We will give examples of cloud systems that are relatively robust to aerosol perturbations, and contrast this with cases where the aerosol has locally strong effects, often through leveraging of mesoscale organization. We will highlight the important role that the aerosol plays in sustaining clouds in the very clean marine boundary layer. Finally, we will consider the possibility that aerosol-cloud interactions might be amenable to parameterization in terms of their system-wide behaviour. This may present a fruitful alternative to the current bottom-up approach to parameterization.

[1] Koren & Feingold (2011), The aerosol-cloud-precipitation system as a predator- prey problem. Proc. Nat. Acad. Sci., 10.1073/pnas.1101777108.

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