

292274 **RAPID**



Elec Del

Journal Title: Eos

Volume: 87

Issue: Fall Meeting Suppl.

Month/Year: 2006 **Pages:**

Article Author: Camp, V E; Anonymous

Article Title: Overview; birth of the Snake
River plain

ISSN: 0096-3941

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Pyroclastic conduits of the late Cenozoic collapse calderas from Japan

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There are many late Cenozoic calderas in Japan. Many of the late Cenozoic calderas are the large-scale collapse calderas of the piston-cylinder type, and consist of collapsed volcanic basin surrounded by arcuate ring faults or array of vents and the surrounding pyroclastic flow deposits. Yoshida (1984) reported intrusive breccia dikes between the subsided block and wall rocks of the Ishizuchi caldron, SW Japan. The intrusive breccias consist of tuff and tuff breccias containing many kinds of rock fragments. Contacts with surrounding rocks are sharp. Some breccia dikes along the marginal ring fracture zone of the caldron, which are composed of welded pyroclastic rocks, probably fill vents from which the surrounding pyroclastic flow deposits were discharged. The matrix of the intrusive breccia is welded ash and/or clastic powder. Fragments vary in size from millimeters to several meters. Local continuity of structures from one fragment to another indicates that the brecciation was not a consequence of explosive action; these are interpreted as intrusive breccias produced by fluidization processes, probably associated with pyroclastic explosions. These breccias were intruded upward to their present positions as part of a fluidization system. Intrusive breccia and tuff within the ring fault complex contain a eutaxitic foliation oriented nearly parallel to contacts. This feature is thought to result from inwardly directed pressures exerted by the dike walls during caldera collapse following eruption of the pyroclastic flows. The eutaxitic foliation indicates that the intrusive breccia and tuff were emplaced as a fluidized system of gas, solid particles, and probably liquid droplets. Mt. Taiheizan is located 20km northeast of Akita, NE Japan. There is the late Miocene to early Pliocene Nibetsu caldron on Mt. Taiheizan. Recent study revealed the details of a contemporary acute pyroclastic conduit consisting of felsic tuff. This Hirasawa felsic tuff dyke is about 5 km long and 100m wide, and it has four facies - massive facies, lithic-rich facies, fluidized network facies, and laminated marginal facies. Just outside of this arcuate pyroclastic conduit, a pyroclastic flow deposit estimated as an outflow from Hirasawa felsic tuff dyke, was found. It has the same mineral compositions and chemical compositions of glass. These tuff dyke and its outflow can be correlated to the submarine pyroclastic mass flow facies. The Hirasawa arcuate pyroclastic conduit with the eruption of pyroclastic flow is considered to have been formed at the earliest Pliocene, and at this time, uplift of Mt. Taiheizan occurred together with the caldera resurgence of Nibetsu caldron. Therefore, the formation of Hirasawa arcuate pyroclastic conduit is thought to have a close relationship with the resurgence of Nibetsu caldron. The Motoisago caldera and the Takebayashi caldera are distributed near Sendai, NE Japan (Takahashi et al., 2006). The pyroclastic conduits of these calderas are presumed at their margin between basements and horizontally stratified caldera-filling tuff beds. The conduits are not welded, but soft and vertically laminated with slumping structures caused by subsidence along the caldera wall. Almond (1971) has classified the pyroclastic conduits into forceful (diatreme) type and permissive injections associated with caldera-collapse. He showed no example of the permissive injections at low temperature. The pyroclastic conduits from these calderas near Sendai might be good examples of this type.

V43C-1832 1340h POSTER

Edifice Collapse: Natural Tool to Probe the Roots of a Volcano

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The most common cause for structural destabilization of stratovolcanoes and dome complexes is intrusion of volatile-rich, viscous silicic magma prior to the forthcoming eruption. In this situation, rapid landslide-induced decompression provokes a strong explosive eruption. Observational data and stratigraphic relationships show two main scenarios of such eruptions. Scenario 1 includes: moderate pre-climactic explosive activity; edifice failure; catastrophic directed blast; (sub)plinian or vulcanian eruption, and fountain-collapse with generation of pyroclastic density currents. Recent examples are Bezymanny 1956, Mount St. Helens 1980, Soufriere Hills, Montserrat 1996. Scenario 2 includes: edifice failure; moderate phreatic explosion; (sub)plinian eruption and fountain collapse with generation of pyroclastic density currents. Recent examples are Harimkotan 1933 and Shiveluch 1964. The cause of two scenarios relate to different levels of magma intrusion with respect to the detachment surface at failure and hence to magma depressurization conditions. That level, in turn, is related to the intensity of destabilizing effect of the intruding magma, and degree of initial (pre-eruptive) instability of the volcanic edifice. Scenario 1 occurs if the detachment intersects the magma body. A magmatic directed blast immediately follows collapse. Scenario 2 occurs if, at failure, the magma body is notably deeper than the detachment surface(s). In scenario 2, only a moderate phreatic explosion first occurs, due to decompression of the superficial hydrothermal system; a vertical magmatic eruption can follow with delay because rising magma needs time to reach the ground surface inside the landslide scar. Many prehistoric debris avalanches of the Kurile-Kamchatka region (10 studied cases) were associated mostly with Scenario 2, which thus seems more common.

V43C-1833 1340h POSTER

Volcanic Hazard Assessment Through Analysis of Physical Characteristics and Distribution of Volcanic Projectiles

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Dealing with hazards at active volcanoes requires detailed knowledge of eruptive history and a good understanding of pre- and syn-eruptive processes. Despite improvement in monitoring systems, such an understanding cannot be based on direct field observations alone. Experimental and theoretical modelling are two essential components of modern volcanic hazard analysis. Volcanic ballistic projectiles (VBP) are a major hazard related to volcanic explosions. They may affect people, ecology, infrastructure and aircraft. In order to determine the potential areas for VBP fall, it is needed to estimate maximum ranges under different explosive scenarios. Each scenario is defined by the kinetic energy calculated from the impact location and its dimension and the physical characteristics of the projectiles (e.g. density, drag coefficient). The kinetic energy derives from the excess pressure in the expanding volatile phase driving the explosion. The design and development of "fragmentation bomb" technology has provided volcanology with the capability of controlled and systematic analysis of the fragmentation behavior of magma upon rapid decompression. Study of samples from several volcanoes has demonstrated a close relationship between open porosity and overpressure required for complete fragmentation of samples (fragmentation threshold). Analysis of the experimentally generated pyroclasts by fractal analysis shows that grain-size distribution is linearly dependent on open porosity and PEF (potential energy for fragmentation). Combination of these two approaches (kinetic energy from the distribution of VBP and potential energy (PEF) from scaled experiments and investigation of experimental and natural pyroclasts), taken together with seismic monitoring provides the potential for a significantly more refined hazard assessment of active, explosive volcanoes.

V43D MCW: 3010 Thursday 1340h

Snake River Plain as a Probe of Mantle-Lithosphere-Climate Dynamics I (joint with PP, T)

Presiding: M Reid, Northern Arizona University; B B Hahan, San Diego State University; A Prokopenko, University of South Carolina; J W Shervais, Utah State University

V43D-01 1340h INVITED

Overview: Birth of the Snake River Plain

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The Snake River Plain (SRP) is marked by a linear track of large, age-progressive calderas (Pierce and Morgan, 1992), the youngest of which is underlain by the Yellowstone mantle plume, which extends to a depth of ~500 km at the eastern edge of the province (Yuan and Duerke, 2005). Plate reconstruction to ~16.5 Ma, places the plume near the western edge of the SRP, contemporaneous with the abrupt onset of dike intrusion and flood-basalt magmatism on the Columbia Plateau, the Oregon Plateau, and within the Northern Nevada rift (NNR). Whereas most workers now embrace a plume-related origin for the SRP, others caution against accepting a similar origin for the other three contiguous provinces. This is understandable in light of more traditional models found in the geological literature, combined with the distinctive geology of each province and their locations in a back-arc environment associated with varying degrees of Basin and Range extension. This overview examines the development of ideas on the origin of the SRP and the associated flood-basalts that lie adjacent to its western margin. Often overlooked in the plume vs. nonplume debate is the fact that competing models of Basin and Range extension and plume emplacement are not mutually exclusive. The SRP, Columbia Plateau, Oregon Plateau, and NNR are clearly distinct in their stratigraphy and geological development. As a group, however, they also appear to be intrinsic parts of a single magmatic system, related in both time and space to the Miocene emplacement of the Yellowstone mantle plume into an environment of back-arc extension. The style of volcanism above the plume was manifested in different ways in each province. From ~16.5-15 Ma, an early phase of dike intrusion (NNR) and flood-basalt volcanism (Oregon and Columbia Plateaus) generated the greatest outpouring of continental basalt on Earth over the last 30 million years. This was followed, from ~15 Ma to Present, by a later phase of bimodal volcanism along the SRP, thus generating the world's only current example of a continental hotpot track. The temporal and spatial relationship of flood-basalt eruption and hotpot volcanism is consistent with the evolution of a plume head-tail pair, as predicted by traditional models of plume emplacement.

V43D-02 1355h INVITED

A Helium Isotope Perspective on Mantle Sources for Basaltic Volcanism in the Northwestern US

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Helium isotope variations in continental basalts provide valuable constraints on mantle source relationships. ³He/⁴He ratios between 7 and 9 R_A (where