

78. Deep, Long-Period Earthquakes in and around Craters of the Moon National Monument, Idaho

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Craters of the Moon National Monument and Preserve (COM), Idaho is located within the Great Rift volcanic rift zone of the eastern Snake River Plain (ESRP). This volcanic rift zone has had eight episodes of volcanic activity over the last 15,000 years with the most recent eruption ending approximately 2 Ka. Seismic stations operated by the Idaho National Laboratory since 1972 and EarthScope's USArray Transportable Array stations installed in 2006 and 2007 have detected eleven micro-earthquakes of magnitudes from 0.5 to 2.5 near the northern end of COM. Of these events, several reside within the ESRP and the remainder fall within the adjacent Basin and Range mountains. Eight events with stable, well-constrained locations nucleated at mid-crustal depths from 15 to 25 km below the surface, seven of which have occurred since February, 2007. Confidence of the hypocenter depths is gained by searching for r.m.s. travel-time residual minima through fixed event depths, plotting predicted arrivals on waveforms, and relocating events with subsets of arrivals (P- and S-phases). These events are anomalous for two reasons: Firstly, the hypocenter depths are uncharacteristic as ESRP earthquakes have occurred at depths of less than 10 km and nearby Basin and Range events typically occur at depths of 15 km or less. The observed focal depths are significant as they are located near and around base of the mid-crustal sill where magma is thought to reside and at depths hypothesized to be source regions for dikes. Secondly, the character of the waveforms differs dramatically from typical brittle-fracture earthquakes observed in the ESRP and Basin and Range. Upon inspection, waveforms from several of these earthquakes are quite similar to waveforms recorded from long-period volcanic events in other active volcanic regions, including having dominant frequencies of less than 3 Hz.

79. Time-Varying Lags Between Short-Period and Very Long Period Strombolian Eruption Seismic Signals at Erebus Volcano, Antarctica

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Erebus volcano constitutes an accessible natural laboratory for long-term monitoring and investigation of Strombolian eruptive behavior. We examine broadband seismograms of Strombolian eruptions from the Erebus lava lake spanning five years and more than 2000 individual events in a new comprehensive catalog. Although Erebus is noted for persistent activity, the frequency of Strombolian eruptions is highly variable. Detailed cross-correlation analysis of the generally similar eruption waveforms shows systematically changing lags (of up to several seconds) between the timing of short period (SP) signals and accompanying very long period (VLP) signals. These changes represent origin time differences between the two primary seismic features eruptions. SP (and accompanying infrasound) signals are generated by the explosive decompression of the gas slug at or near the surface of the lava lake, while VLP signals are driven primarily by mass advection during the rise and expulsion of the gas slug and subsequent post-eruptive refilling of the conduit system. These SP-VLP timing variations are single-station measurements that are consistent at four long-running broadband stations. They show no obvious correlations with eruption size, spectral characteristics, eruption frequency, SP and VLP waveform similarity, and lava lake morphology. We offer two plausible explanations for the lags, noting that these two mechanisms may be working in conjunction. First, the lags could be caused by variability in the inherent rate of ascent for the gas slug (e.g., due to magma viscosity changes). This seems doubtful given the general stability in lava lake behavior and geochemistry. More likely, the SP-VLP lag may be highly sensitive to conduit geometry changes (e.g., effective constriction depth and/or aperture) that affect the timing of the VLP signal relative to slug emergence at the lava lake. <http://erebus.nmt.edu>

80. Can Directional Resonances Be Used to Map Intensely Deformed Fault Zones of Mt. Etna Volcano?

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Mt. Etna is characterized by flank instability of the eastern to south-western portions of the volcanic edifice, producing down-slope movements with rates up to

several decimeters in a month during eruptive events of the 2002-2003 activity. The unstable sector is bounded to the North by a E-W transtensive fault (the Pernicana fault system), extending from the NE Rift to the coastline of the Ionian Sea for a length of >18 km. The western portion of the Pernicana fault system (close to Piano Pernicana area) is characterized by the most intense deformation. In this area we have performed volcanic tremor measurements on a dense grid along and across the fault zone. Ambient vibration measurements are also performed along a second fault (Tremestieri fault) which confines the slip of the eastern flank to the south-east. The analysis using both microtremors and local earthquakes recorded in these faults shows persistent polarization of ground motion. Horizontal-to-vertical spectral ratios (HVSr) show large directional resonances of horizontal components within the damaged fault zones. The resonance occurs around 1 Hz at Piano Pernicana, and around 4 Hz in the Tremestieri fault zone. The resonance amplitude in the HVSr's seems to be fairly well correlated to soil gas anomalous concentrations (in particular, radon and CO₂ both considered tracer gases of major crustal discontinuity) in the two fault zones, suggesting that both the effects are linked to local fracturing conditions. According to previous results on velocity anisotropy in the shallow crust, we believe that a role on polarization could be played by stress-induced anisotropy and micro-fracture orientation in the near-surface lavas. The occurrence of directional resonances, if confirmed in other faults, can be a powerful tool to map buried damaged fault zones on the Mt. Etna volcano.

81. Cyclic Surface Deformation from GPS Geodesy at Soufriere Hills Volcano, Montserrat, WI Between 1995-2007: Constraints on Magmatic Fluxes and the Plumbing System of an Erupting Arc Volcano

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Melt generated within the "subduction factory" may be considered constant over very long timescales (>Ma), yet rates of magma transport and eruptive episodes are episodic at timescales encompassing millennia and centuries to hours for many arc systems. Thus a complex architecture of connected magmatic pathways is likely present beneath many arc volcanoes. Often, this "plumbing system" is not easily elucidated by seismic imaging techniques, sparking lively debate as to the true nature of these systems relative to simple geophysical models. Time series of magma efflux and surface deformation were used to quantitatively constrain magma transfer into and within the deep (>12 km) crustal plumbing of the Soufrière Hills volcano (SHV) over a 12-year cycle of active eruption and surface efflux followed by discrete pauses. We infer that the deep supply to the SHV system is continuous with a periodicity of 4-6 years and never drops below ~0.5-1 m³/s during three cycles of effusion and pause; this minimum supply is similar in magnitude to both the mean measured eruptive efflux (including pauses) (~0.7 m³/s) and the mass accumulation due to crustal convergence (~0.6 m³/s). Deep fluxes rise synchronously from this background magnitude in times of active eruption (~1-5 m³/s), are augmented by deflation (~1-2 m³/s) of a reservoir centered at ~12 km, and pass through an upper magmatic reservoir. An eruptive pause, which is accompanied by surface inflation, is marked by a decrease in supply from the deep crust to the shallow crust, as the deep reservoir begins to re-inflate. For our preferred two-reservoir model, these observations implicate the deep system in controlling short-term (~3-5 yr) eruptive periodicity. At SHV, a model with continuous supply of magma from the deep crust/mantle into a voluminous and compliant deep crustal reservoir, episodically-valved below the shallow crustal reservoir is consistent with the GPS-derived surface velocity field and the efflux record.

Central California Coast Earthquake Hazards

Poster Session · Thursday PM 9 April

12. GPS Measurement of Crustal Deformation in the Central California Coast Region

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The central coast region of California, west of the San Andreas fault from ~35.7°N southward to ~34.6°N, is a zone of right-lateral transpression, and examination of seismicity, focal mechanisms, and geologic data suggest that this region is comprised of several rotating crustal blocks. Relatively little geodetic data have been collected in the coastal region, particularly prior to the 2003 M6.5 San Simeon earthquake.