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A Giant Blast Associated with Flank Collapse of the Canadas Volcano (Tenerife, Canary Islands) 0.18 M.y. ago

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A giant blast deposit covering much of central and western Tenerife (Canary Islands) represents the terminal explosive event of the Las Cañadas volcano ca. 0.18 million years ago. The thickness of the deposit is some 8 m near source and ca. 1 m at near-coastal exposures. Its large areal extent and volume of solidclasts expelled (several km^3) are much larger than previously recognized blast deposits. The blast expanded radially and concentrically from the source area unlike in restricted sectors as in Mt. St. Helens and Bezymianny. The deposit consists of a basal unit generally <50 cm thick and fine-grained and poorly sorted proximally but well-sorted and in the coarse ash to fine lapilli range in medial and distal outcrops. It is also generally discontinuously layered with minor dune and mound structures reflecting unsteady flow. In the distal and medial outcrops locally abundant grooves subparallel to transport direction suggest scouring by longitudinal vortices. The bulk of the blast deposit is more massive, almost invariably inversely graded, a significant fraction of its rock content reflecting locally scoured lithology. High turbulence is inferred to explain the formation of the basal layer over most of the area. The massive central part may have formed by deposition from suspension. The paucity of juvenile material (except locally) is thought to indicate fragmentation of a suddenly depressurized hydrothermal system during slope failure. The abundance of fresh miarolitic syenite xenoliths and local presence of very crystal-rich, slightly pumiceous phonolite suggests that the upper part of an active hot magma resovoir system was depressurized and fragmented as well. Lahars are associated with the blast deposit especially along the canyon such as Barranco de Orchilla. The association of the blast deposit with the Abrigo ignimbrite of the same age is still uncertain. Several major types of hazard were associated with the event: sector flank collapse, lahar, concentric high speed blast and tsunamis.

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Mantle-Derived Noble Gases in the South Aegean Volcanic Arc as Indicators for Incipient Magmatic Activity

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The islands of Nisyros, Yali, Kos, Santorini, Milos, Poros, Methana and Aegina constitute the South Aegean volcanic island arc, which is a result of northward-directed subduction of the African plate beneath the Aegean microplate. The islands of Nisyros, Santorini, Milos and Methana are considered today the most active areas in terms of a potential volcanic reactivation. Therefore, these islands were chosen for a detailed noble gas investigation. The combination of noble gas ratios, such as $^3He/^4He$ and $^{20}Ne/^{22}Ne$ compared to major and trace gas compositions will allow an appropriate discussion on magma degassing, the amount of atmospheric, meteoric and hydrothermal contamination, as well as the determination of equilibrium temperatures in the hydrothermal systems. During the past year priority was given to gas and water analyses for the following reason. On Nisyros island, high-seismic activity occurred from June to September 1997 and were accompanied by increased tectonic and fumarolic activity in the hydrothermal crater field. In this respect, the scheme of events is comparable with the violent hydroclastic and gas explosions in 1873 and 1888. The observed $^3He/^4He$ and $^4He/Ne$ ratios in gas condensates and hydrothermal waters from the islands of Nisyros, Santorini, Milos and Methana range from 1.419 x 10^{-6} to 7.5 x 10^{-6} and from 0.274 to 12.634, respectively. They fit well into the array of active island arc samples which mark a mixing line between atmospheric $^3He/^4He$ ratio of 1.4 x 10^{-6} and mantle derived helium with a maximum ratio of 10 x 10^{-6}. The $^3He/^4He$ ratios in the Nisyros condensates as well as in some geothermal waters from Milos reflect well the high amount of mantle derived primordial ^3He, which in the case of Nisyros, may be related to magma degassing.

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Evidence for the Largest Explosive Eruption in Historical Times in the Andes, AD 1600, at Huaynaputina Volcano, Southern Peru

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The largest Plinian and ignimbritic eruption in historical times (VEI 6) in the Andes took place in AD 1600 at Huaynaputina, a small eroded stratovolcano located on a high volcanic plateau in southern Peru, in the Central Andean Volcanic Zone, 75 km ESE of Arequipa (16°37'S, 70°51'W). According to chronicles, the eruption began on February 19th with a 13-19 hour-long Plinian stage following 4 days of intense seismic activity, and included at least nine distinct events until March 6th. The erupted tephras totalling 10.35-12.10 km^3 bulk volume stratigraphically include eight deposits: 1) a widespread (1-cm-isopach area ~115 000 km^2) and voluminous (~7 km^3) pumice-fall deposit which includes an ash-rich pyroclastic-flow deposit interbedded in some proximal sections; 2) ignimbrites 1.6-2 km^3 from channeled pumice-rich flows and from unconfined ash-flows that travelled ~50 km from the vent across barriers ~1,000 m high; 3) companion ground-surge and ash-cloud surge deposits; 4) several widespread co-ignimbrite ash layers; 5) base-surge deposits with accretionnary lapilli interbedded in the ignimbrite sequence; 6) a crystal-rich flow and surge deposit which overlaps the plinian fallout area to the WNW; 7) unconfined ash flows and ash-cloud surges, and; 8) late ashfall and ash-cloud surge deposits. Mass flows and 'secondary ignimbrites' eposits amounts 5-20 m thick on the steep edges of the plateau and in the high-gradient radial channels showing that the removal of the tephra was topographically-controlled. In addition, pyroclastic flows choked the Rio Tambo canyon and formed two temporary lakes whose catastrophic breaching released large-scale debris flows which swept down the 120-km-long valley to the Pacific Ocean. Disruption of a hydrothermal system and hydromagmatic interactions have triggered or enhanced the large-scale 1600 AD eruption. Although the voluminous eruption did not involve caldera collapse, ring-fractures cut the floor of the pre-1600 AD horseshoe-shaped caldera and of the 1600 AD vents, pointing to the onset of a funnel-type caldera collapse. Finally, the paroxysmal eruption generated a severe regional aftermath and global climatic effects over the early seventeenth century.

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Petrological Constraints on the Huaynaputina Volcano AD 1600 Explosive Eruption

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The largest explosive eruption in historical times in the Andes took place in AD 1600 at Huaynaputina, a small eroded stratovolcano of southern Peru (Central Andean Volcanic Zone) (Thouret et al., 1997; 1999; de Silva and Zielinski, 1998). This eruption lasted 15 days and devastated an area 60 km around the vent and shook Arequipa city 75 km away. Bulk rocks ICP-AES analyses indicate that the erupted magma is a medium to high-K calc-alkaline dacite. The mineral assemblage encompasses plagioclase (An_{68-43})+ biotite (Mg# = 56-71) + amphibole (Mg# = 61-82) + magnetite + apatite ± ilmenite. The pumices from the plinian fallout deposit as well as from the pumice-rich pyroclastic flow deposits are porphyritic with a modal crystal contain (recalculated to 100% vesicles-free) between 25 and 30 in volume percent. Major and some highly incompatible trace elements bulk rock compositions through the deposits shows a slight evolution during the eruption. The Plinian fallout magma is slightly less differenciated (SiO_2% = 65.4 ± 0.3; MgO% = 1.8 ± 0.1; Th (ppm)= 5.1 ± 0.3) than the magma produced during the following ignimbritic phase of the eruption (SiO_2% = 66.3 ± 0.4; MgO% = 1.6 ± 0. 1; Th (ppm)= 6.0 ± 0.3). A slight average evolution in the composition of the mineral assemblage correlates this general trend as well as the composition of the rhyolitic glassy matrix of the pumices: SiO_2% = 72 ± 1; MgO% = 0.5 ± 0.1 in the Plinian fallout deposit for SiO_2% = 76 ± 1; MgO% = 0.15 ± 0. 1 in the ignimbrites. However the presence of a few more calcic plagioclase (>An75) indicates a differenciation from a more primitive magma. Furthermore, ongoing investigations on the volatiles content of the erupted magma seems to show a higher initial volatiles content in the Plinian phase than during the ignimbritic phase of the eruption. These observations are thought to represent the eruption from a zoned dacitic magma chamber formed by differenciation from a more basic magma. The initiation of the eruption might have been triggered by the high volatiles content of the magma after the differenciation of a new magma batche inside a superfial magma chamber, even if hydromagmatic interactions with a superficial hydrothermal system (as shown from the large amount of oxidized or hydrothermaly altered lithic fragments throughout the Plinian fallout) might have enhanced the explosivity of the initial phases of the eruption.

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Application of Digital Stereo Imaging of Aerial Photographs on Volcanic Studies

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We emphasise the importance of the use of Digital Elevation Models (DEM's) derived from digital stereo imaging of aerial photographs in studies on volcanoes. Relative to most types of remotely sensed data, the resolution of the DEM's derived from this process are higher and therefore prove more valuable in some aspects of volcanic studies that implore remote sensing techniques. Problems that concern detail and which cannot be resolved by more advanced digital remote sensed imagery may have a solution with digital stereo processed images of aerial photographs. Available aerial photographs, which can date back up to several decades, can be used and its potential value maximised. When three-dimensional images of topography that pre-date a volcanic event are required, and images taken from new and more advanced imaging techniques are not available, aerial photographs become important. This particularly applies for volcanic terrain where rapid changes in topography have occurred due to volcanic activity.

We present two cases on the successful use of digital stereo processed aerial photographs for volcanic studies. The first case is with the study of the small volcanic crater of Mayon Volcano, Philippines. The dimensions of its vent and crater were determined by digital stereo imaging for the creation of the correct geometry of the summit. This geometry was used in the Computational Fluid Dynamic modelling of the volcanic jet for the first and second phases of the 1984 and the 1993 eruptions. The second case is on the study of the Iriga debris avalanche deposit. The DEM derived from the aerial photographs were used to calculate the volume of the debris avalanche deposit and for the analysis of its distribution and structure. In the analysis of the morphology of Mayon (post 1984) and Iriga, the aerial photographs were used to complement radar data that were available on the area. These were important in regions that were not well represented by the radar image due to shadowing and foreshortening effects.

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