ICTP DIPLOMA PROGRAMME IN EARTH SYSTEM PHYSICS 2015-16

SYLLABUS

PHYSICS OF VOLCANOES - {12 Lectures = 18 hours} E. Rivalta

General introduction on volcanoes. Shapes of volcanoes. Types of volcanism. Volcano-tectonics. Magma composition, thermodynamics of magma generation, shallow and deep geotherms, decompression melting, role of water and other volatile species, physical properties of magma, magma evolution at different depths. Magma transport through the crust. Different schools of thought for dike propagation (viscosity-dominated regime and fracturing-dominated regime). Analogue experiments on fluid-filled crack propagation. Examples of deep magma transport for some volcanoes (Ell Hierro, Ejyafjallajokull). Models of pressure evolution in the plumbing system due to top-down effects (eruption, unloading) or bottom-up (fresh intrusions from below heeating and stirring the magma in reservoirs). Crustal deformation for different tectonic settings, Mogi model, Sills, ellipsoids, calderas. Elemetary dislocations. Rectangular dislocations. Distributed models of slip. Equivalence of different shapes in terms of crustal deformaiton. Dike dynamics in the volcanic edifice. Examples of volcano seismicity linked to dike intrusions and conduit processes, moment tensor, full moment tensor, earthquake scaling laws for volcanic events. Overview of the types of eruption including the physical mechanism behind it (lava flow, lava fountain, explosive eruptions, dome collapse, pyroclastic flow, lahar). Bubble nucleation, bubble expansion and cohalescence, anular flow, slug flow, strombolian eruptions, hawaiian eruptions. Models of conduit flow, models of magma viscosity, crystallization, effects of crystals and bubbles, criteria of fragmentation Analytical models of caldera collapse. Analog experiments of caldera collapse, critical magma output to cause collapse, comparison of caldera collapse episodes, vertical-CLVD focal mechanisms. Volcano statistics. Volcano-volcano and earthquake-volcano interactions. Eruption triggers (earthquakes, sudden changes of surface mass load). Volcanic hazard. Cascade effects, landlslide, tsunamis. Interaction with climate.