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UNDERSTANDING AND FORECASTING UNREST AT FAST AND SLOW VOLCANOES

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ABSTRACT

This talk examines the behaviour of fast volcanoes that erupt quickly with paroxysmal explosive eruptions, and slow volcanoes that erupt over extended periods without such paroxysmal activity. I review activity at four fast and four slow volcanoes, highlighting the main events and commonalities in behaviour among the different systems. In terms of forecasting, fast volcanoes typically have short 1-3 month precursory periods prior to the climactic eruption, while slow volcanoes commonly have an extended period of considerable uncertainty regarding the presence or absence of new magma, as well as unanticipated accelerations in activity. Fast volcanoes are associated with magmas having elevated volatile contents (up to ~7 wt. % H2O), rapid magma ascent rates, and rapid declines in activity after the climactic eruption. Fast volcanoes also exhibit well defined magma plumbing systems with mobile volatile-rich magma, with the plumbing system sealed between the top of the shallow magma reservoir and the surface prior to the climactic eruption. Slow volcanoes have complex plumbing systems comprising cracks, fractures, dykes, and sills and magmas that are crystal-rich, partly degassed, and rheologically sluggish. Slow volcanoes experience a progressive opening of their systems as magma intrudes and fractures country rock, allowing degassing to occur. The degree to which a system is opened is determined by the rate at which new magma is emplaced at shallow levels. Slower rates of emplacement enhance the opening process due to a cumulatively high number of fractures and increased fracture density which develop during the extended period of unrest. Many systems both fast and slow receive inputs of mafic magma which can drive activity seen at the surface. A series of recently developed tools is examined and discussed in order to provide an improved means of forecasting activity at both types of volcanoes. These include assessment of early phreatic activity and associated gases, Vp /Vs ratios of magma by seismic tomography, and estimates of magma volume from precursory seismicity. What is required now are protocols which integrate these approaches in a manner which is useful for accurate forecasting.