Mitigating volcanic hazards through geophysical monitoring and research

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Volcanoes are complex systems that require a multi-disciplinary scientific approach to fully understand, encompassing the fields of geology, geophysics, geochemistry, hydrology, petrology, physical modeling, and remote sensing, among others. For all these fields, the line between monitoring and research is blurry; research can produce new tools that become operationalized over time (e.g., identifying seismic event families through cross-correlation), and observations made while viewing data from monitoring networks can feed into new research investigations (e.g., cause of changes in the frequency content of seismic events). This feedback loop between research and monitoring is fundamental to mitigating volcanic hazards.

Monitoring of Mount Rainier (Washington) provides a good example of this feedback. Through careful geologic research, it is now known that Mount Rainier has produced at least 8 large lahars (or volcanic mudflows) in the last 6,000 years (most recently ~500 years ago) that reached into what are now heavily populated areas of Puget Sound. Most of these lahars have occurred in association with eruptions. A key strategy for lahar hazard mitigation is therefore to establish a robust volcano monitoring system that can detect early warning signs of a potential eruption. Given the degree of societal exposure to volcanic hazards, this monitoring system needs to be capable not only of routine monitoring tasks (e.g., locating earthquakes), but also detecting subtle phenomena in real time that may provide earlier warning or improved situational awareness. From seismology alone, these capabilities include detecting changes in subsurface velocity structure through techniques such as coda-wave interferometry and noise cross-correlation, and detecting changes in event location through methods like such as envelope- and template-based cross-correlation. An additional required capability is detecting lahars, including information on flow size and speed – a capability that will require implementation of relatively new-to-volcano-science techniques such as low-latency back-projection-type processing of seismic and infrasound array data. Enabling these and other capabilities requires a substantial expansion of the current

monitoring network at Mount Rainier – a network which, when built, will assuredly provide data that will feed back into new research investigations.