Air quality monitoring for volcanic emissions: briefing document

Volcanic ash and gas are types of airborne pollution and should be monitored to check if air quality is exceeding public health standards. Government agencies may want to use air quality data to provide public information and recommend actions associated with different levels of an air quality index (e.g. https://www.airnow.gov/aqi/aqi-basics/).

Air quality monitors may be real-time or may provide retrospective data. Real-time monitors are more useful for immediate public health advisories.

Ideally, regulatory-grade instruments would be installed but these are expensive, challenging and time-consuming to install in a crisis, and need regular maintenance. Cost also prohibits installation of a monitoring network. Low-cost sensors are a good alternative during a crisis and are suitable for establishing a network, with sensors across populated centres. The data are not as reliable as regulatory data but may be used as an indication of air quality, rather than absolute values. Therefore, advisories associated with the data should be given with caution. The monitors recommended below are all low-to-medium cost.

Particulate monitoring

The two main low-to-medium cost **non-regulatory** instruments used for airborne particulate monitoring during volcanic eruptions are the TSI DustTrak aerosol monitor and PurpleAir sensors.

	DustTrak	**PurpleAir**
	 DustTrak DRX Aerosol Monitor 8533	 PA-II-SD
Cost	Approx. $US 15,000	$US 279 per unit
What they measure/report	Simultaneous measurement of PM_1, $PM_{2.5}$, PM_4, PM_{10}, TSP	Simultaneous measurement of PM_1, $PM_{2.5}$, PM_{10}, Temperature, Humidity Derived air quality indices (e.g., USEPA $PM_{2.5}$ AQI)
Power requirements	Battery life is approximately 6-8 hours.	Work best with mains power. Can be run for several days from a power bank. Can be run from vehicle with USB outlet.
Data access	Data must be downloaded from instrument.	With access to wifi, data can be uploaded to PurpleAir's cloud where it can be visualised in real time, on a

		map with different averaging periods and with clear links to health information and advice. Without wifi, the SD card-enabled devices save data to a microSD card which can be extracted and the data downloaded.
Are they regulatory quality?	No, but the DustTrak is used extensively for air quality research around the world, including during volcanic eruption (e.g. the Soufrière Hills).	No, but the PurpleAir has been tested against other low-cost PM sensors and performs well and is an excellent choice for setting up a network of sensors.
Ease of use and maintenance	Easy to use, very little training required. Requires daily calibration and data download every few days. Should be placed in a sheltered (from rainfall/ash) environment such as a veranda. Environmental enclosures can be purchased.	Easy to use, very little training required. Requires data download every few days if no wifi. Installation is straightforward but important to consider location. Should be checked and cleaned (to remove insects) frequently.

Gas monitoring

The following low-cost gas detection techniques are **non-regulatory** methods for assessing gas concentrations. The methods presented below can help characterize gas concentrations over time and space, for the purposes of evaluating hazards. These instruments have a higher minimum detection limit and lower resolution than regulatory methods but are cheaper and require less infrastructure.

Technique	Gas detection tubes	Personal or handheld gas monitors	Better resolution or broadcast capable sensors
		  Dock station  Aeroqual	 AreaRAE  Aeroqual
Cost	~US $500 for Hand pump + $100-150/10 tubes	~US $400-1,000/ monitor (+ ~$1,000 – $3,000 for docking station/calibration gases, except Aeroqual)	~US $10,000 – $20,000

Example manufacturers/products	Drager, RAE systems, Sensidyne	Industrial scientific, BW technologies, Drager, Aeroqual	RAE systems (areaRAE or multiRAE), Interscan corporation, (GasD 8240), Aeroqual
What they measure	Single gas concentration in ppm (i.e SO_2, H_2S)	Single or multiple gas concentration in ppm (i.e. SO_2, H_2S, CO_2)	Single or multiple gas concentration in ppm (SO_2, H_2S, CO_2, others)
Resolution	0.1 - 1 ppm	0.1 ppm	0.1 - 0.01 ppm
Range	0.1 - 200 ppm options	Generally, 0 - 200 ppm	SO_2: 0-2, 20, or 100 ppm
Power requirement	none	Internal battery	AC, limited internal battery, or configure for external battery
Data access	Direct readout on tube	Screen readout + logging capability. Data download via stand-alone or networked docking station	Log onsite or telemetered
How to use	Operator needed for manual pumping of gas through tube. 3-20 min/sample	Can use for personal protection or field deploy in environmental enclosure	Deploy to field location for time series data. Some have wireless radio option for real-time data acquisition
Ease of use and maintenance	Easy, little training required. Used tubes may be considered chemical waste so consult local regulations for disposal.	Easy. Basic technical skill needed for docking station set-up and badge programming. Monthly calibration recommended. Calibration gas cylinders required.	Basic technical expertise required. Aeroqual monthly/quarterly maintenance: filter replacement, flow/leak and calibration checks, clean inlet. Pump replacement 12-18 months. AreaRAE maintenance as needed: sensor, filter, battery, pump replacement.
Limitations	Single data point manually collected in time and space.	Not wifi enabled - manual data download required, except Aeroqual 300/500 has voltage output/relays for datalogger interface.	Wireless capability is 2-3 km. Some configurable with 900 MHz radio or cloud-based user interface for real-time, remote access.

Written by Tamar Elias (US Geological Survey), Carol Stewart (Massey University, NZ), , Claire J. Horwell (Durham University, UK), David Damby (US Geological Survey). NB. mention of example brand names does not indicate endorsement by IVHHN or our employment institutions. Version 1.5. Last edited 16 April 2021.