THE INTERACTION OF A LEADING AND TRAILING PYROCLASTIC DENSITY CURRENT: INSIGHTS FROM EXPERIMENTS

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ABSTRACT

Pyroclastic density currents (PDCs) are hot, ash-laden, density-driven currents created by volcanic eruptions. As a PDC flows away from its source the current loses momentum which allows its particle load to settle out, and its turbulent eddies engulf ambient air into the current. Both of these processes work in conjunction to cause buoyancy reversal and lift-off of the current as a vertically rising plume. The quicker density decreases, the less time and distance is needed to lift-off. Typically, PDCs flow as a single current, but in some volcanic eruptions multiple PDCs can be generated within seconds to minutes of each other and flow in the same direction, such as those observed at Mt. St. Helens (1980) and Colima (2015). In this situation, it may be possible that the trailing current flows into a leading current. If the leading current modifies the ambient surroundings, the dynamics of the trailing current may change as a result. To examine this premise, laboratory experiments were conducted through the creation of small-scale, analogue density currents. Experiments consisted of a leading current and a trailing current with the same initial conditions, and the trailing current flowed into the leading current after a certain amount of time. In all cases, buoyancy reversal occurred when enough particles settled from the current. In almost all experiments, the result differs from the expected behavior, shown through a change in lift-off distance, which is thought to be modified by entrainment. Entrainment and deposition rate have an inverse relationship, where greater entrainment leads to slower deposition by decreasing the sedimentation rate. An increase in entrainment leads to an increase in lift-off distance. The degree of entrainment can have effects in nature, as observed in the lateral blast of the 1980 eruption of Mt. St. Helens, where a trailing current appeared to overrun a leading current, and this may lead to uncertainty in forecasting volcanic hazards.

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