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# Basaltic tephra from monogenetic Marcath Volcano, central Nevada

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ABSTRACT

Monogenetic volcanic eruptions are generally assumed to last to tens of years and produce frequent, intermittent explosive activity that creates eruption columns up to ~10 km in elevation. Although this view fits the historically observed eruptions, few data have been collected about the range of durations and eruption sizes possible from monogenetic events. Examining other eruption deposits can help clarify the range of eruption styles and sizes possible from future explosive monogenetic eruptions. The ~38 ka Marcath event at Lunar Crater Volcanic Field, Nevada, produced a scoria cone, two tephra fall deposits, and a lava field. We reconstruct the activity that produced the largest tephra fall deposit. Explosive activity produced an eruption column up to ~7 km and a volume of about 0.018 km$^3$. The Marcath tephra-forming activity was small compared to other characterized scoria cones. Post-eruptive remobilization of the deposit has occurred especially around the margins through both fluvial and eolian processes and has likely removed at least 0.001 km$^3$ of fine material from the distal portions of the deposit.



## 1. Introduction

A growing number of studies are showing that small volume, monogenetic, basaltic scoria cones are often accompanied by tephra fall deposits that extend up to tens of kilometers from vent (e.g. Ort et al., 2008; Pioli et al., 2008). This suggests that the hazards from this abundant volcano type might include substantial eruption columns that, while not as extensive as their better-studied subplinian and plinian counterparts, nevertheless pose potential hazards to nearby populations, infrastructure, and to air traffic. However, relatively few datasets and eruption column reconstructions have been published on this important type of eruption. Here we present data on a tephra fall unit associated with the Marcath scoria cone in the Lunar Crater Volcanic Field, Nevada, western USA (LCVF). Like other small volume and old (in this case ~38 ka; Shepard et al., 1995) fall sheets, the Marcath deposits have experienced pedogenic and erosional processes that complicate analysis of isopach and isopleth data. We apply both deterministic and Bayesian approaches (Fierstein and Nathenson, 1992; Burden et al., 2013) to volume estimation. While the resulting mean volumes are similar, the latter approach is preferred because it produces a probability distribution of volumes that quantifies uncertainty. The Marcath products and reconstructed eruption processes are compared with other datasets on small-volume basaltic eruptions; Marcath was apparently similar to the Kilauea Iki eruption (Parfitt, 1998; Parfitt and Wilson, 1999) and on the spectrum of Hawaiian to violent Strombolian eruption styles (Valentine and Gregg, 2008) was somewhat closer to the former.

## 2. Geologic setting

The Basin and Range province of the western United States has experienced extension for up to ~20 Ma (Christiansen and McKee, 1978). Widespread Tertiary ignimbrites that overlapped with extensional tectonics were followed by basaltic volcanism over the past ~11 Ma up to geologically recent times (e.g. Connor et al., 2000; Valentine and Perry, 2006). Lunar Crater Volcanic Field (LCVF) in central Nevada has experienced monogenetic volcanism for at least ~6 Ma (Yogodzinski et al., 1996; Hintz and Valentine, 2012). LCVF is a narrow, north-northeast trending band of Pliocene–Pleistocene volcanoes stretching ~100 km long and ~20 km wide (Foland and Bergman, 1992; Yogodzinski et al., 1996). There are at least 100 Pleistocene scoria cones with attendant lava fields, and four maars in the northern part of the volcanic field (Pancake Range; Valentine et al., 2011; Valentine and Cortés, 2013). Activity within LCVF has migrated generally northward over time (Foland and Bergman, 1992; Yogodzinski et al., 1996). Previous work there has focused primarily on petrology and geochemistry of lavas and xenoliths (Bergman et al., 1981; Yogodzinski et al., 1996) and on geomorphology (Dohrenwend et al., 1987; Shepard et al., 1995), with only recent focus on the physical volcanology of the field (Valentine et al., 2011; Hintz and Valentine, 2012; Valentine and Cortés, 2013).

Marcath (also called Black Rock volcano) is the youngest volcano in LCVF. The Marcath tephra, being the youngest in the volcanic field,

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is overlain only by a thin desert soil and is accessible by digging shallow trenches and by exploiting pre-existing prospector's pits that were mechanically excavated. The area is arid and has been since before the Marcath eruption (Dohrenwend et al., 1987), and the average altitude is 2000 m, so there is only sparse vegetation. Soils are dominated by eolian sand, silt, and evaporite minerals.

## 3. Deposits

### *3.1. Scoria cone, spatter rampart, and lava flow*

The Marcath eruptive products comprise a scoria cone and spatter rampart (volume of ~0.09 $km^3$), a lava field (~0.04 $km^3$) to the west, and tephra deposits to the northeast and south, with a gap between the two tephra deposits (Fig. 1). The elongated spatter rampart extends to the southwest of, and is partially buried by, the main cone. It is composed primarily of variously welded bombs and lapilli of basanite and tephrite composition (Cortés et al., 2014). Many of the bombs are ribbons or spindles and show partial fluid fit to other material within the rampart, indicating that the clasts were fluid when they landed.

The Marcath lava field consists of at least two lobes which extend about 3.5 km to the west of the main cone. Both lobes are composed of a'a lava with thick flow fronts up to ~5 m high. The southern lobe is buttressed against the northern lobe, indicating that the northern lobe reached its maximum distal extent in that area before the southern lobe. Numerous flow features, such as levees, collapsed lava tubes, and mounds interpreted as rafted fragments of the scoria cone are present on the flow field. The measured runout distance of 3.5 km suggests a volumetric discharge rate between ~0.01 $m^3$/s and ~12 $m^3$/s (Walker, 1973). Because this is an a'a flow, a discharge on the higher end of this estimate is likely, but no further constraint is possible from available data.

### *3.2. Tephra*

The main Marcath tephra fall deposit is traceable up to ~5 km northeast of the cone, forming a dark grey unit of basaltic lapilli that mantles topography, with a thin desert soil on top, and is progressively thinner and finer-grained away from the Marcath cone. Grain size and sorting fall within characteristic ranges for a coarse grained tephra deposit (Walker, 1971). Lapilli include equant and elongate scoria. Equant scoria clasts have abundant vesicles up to 2 mm in diameter; most vesicles are much smaller than 2 mm and are distributed evenly within the clasts. Elongate scoria clasts typically have fewer vesicles in bands parallel to the long axis of the scoria. The deposit also contains euhedral to subhedral, monomineralogic megacrysts of olivine, clinopyroxene, plagioclase, and amphibole (magnesio-hastingite/pargasite; Leake et al., 1997) up to ~4 cm in size (Cortés et al., 2014). These megacrysts are apparently in equilibrium with the melt and are not considered xenoliths.

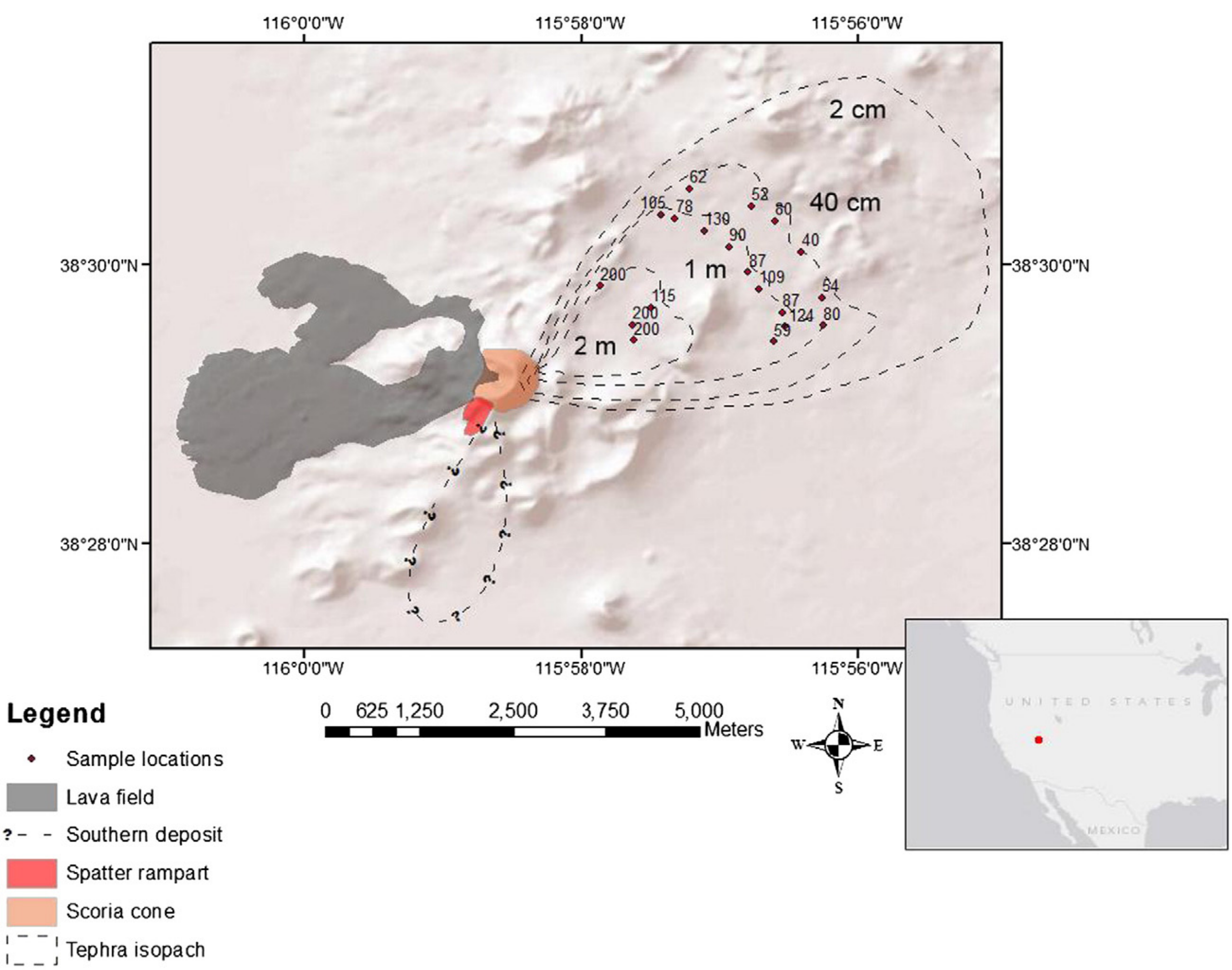


**Fig. 1.** Eruption products from the ~38 ka Marcath event (Shepard et al., 1995), including lava field (dark grey), scoria cone (black), spatter rampart (red), and tephra isopachs (dashed lines). Large numbers indicate thickness of isopachs, plotted to match points as closely as possible. Numbers next to points indicate deposit thickness in centimeters. Heavy dashed line indicates approximate boundaries of southern deposit which was not characterized in detail in this work. Grey areas indicate older scoria cones where fall deposit has likely eroded. 2 cm isopach is the approximate boundary of deposit determined in field, but samples were not collected at this margin.