

Latest Research at El Malpais Reveals Dating Errors

By A. William Laughlin

El Malpais National Monument was created to preserve some of the youngest and most spectacular volcanic rocks within the continental United States. These cinder cones and lava flows are part of the Zuni-Bandera volcanic field which in turn is just one of several volcanic fields that form a northeast trending alignment that extends across Arizona and New Mexico. Geologists refer to this alignment as the Jemez lineament. Although geologists have long known that the volcanoes and lava flows of the Zuni-Bandera volcanic field are very young, it has only been within the past 20 years that serious attempts have been made to determine the age of this volcanic activity. In the mid 1970s, we obtained potassium-argon dates on some of the older lava flows from the Zuni-Bandera volcanic field. These dates suggested that the older flows are about 1.4 million years (Ma) old.

In the late 1980s and early 90s, a group of researchers from Los Alamos National Laboratory, the University of Arizona, and New Mexico Institute of Mining and Technology obtained an additional dozen potassium-argon and argon-argon dates from the volcanic field. The results of our second study indicated that our prior dates of about 1.4 Ma were in error (anomalously old). Our new results (Laughlin et al., 1993) indicated that there were three major pulses of volcanic activity within the Zuni-Bandera volcanic field. The first of these, which occurred about 700 thousand years ago (700 ka), produced basalt flows south and west of the Monument. A second pulse, which produced flows in the western part of the Monument, in the Chain of Craters area, took place between 150 and 110 ka. The third and youngest pulse of volcanic activity produced the spectacular Bandera and McCartys flows as well as the flows from the Lost Woman, Twin Craters, and Paxton Springs volcanoes. In this second study, we were unable to date these youngest flows.

In late 1992, a third geochronological study of the volcanic rocks of the Zuni-Bandera volcanic field and El Malpais National Monument was begun by researchers from Los Alamos National Laboratory, New Mexico Institute of Mining and Technology, and the New Mexico Bureau of Mines and Mineral Resources working with NPS staff. The major goal of this third study was to date the youngest volcanic rocks of El Malpais NM not only to aid in understanding the volcanic history of the area but also to provide a test

area for calibrating newly developed dating techniques. To accomplish this goal, four different dating methods have been applied to these lava flows and volcanoes: argon-argon, radiocarbon, helium-3 surface dating, and uranium-series dating. At least two different methods have been applied to three different flows: the Bluewater flow (uranium-series and helium-3), the Bandera flow (radiocarbon, helium-3, and argon-argon) and the McCartys flow (radiocarbon and helium-3). Results on each of these flows are discussed below.

The Bluewater flow, which is probably the oldest flow of the third pulse, is exposed in the valley west of the town of Grants and outside the Monument. Prior to our most recent work, we had obtained two potassium-argon dates of 5.69 and 2.23 Ma on this flow. These dates were clearly anomalously old because of "excess" argon incorporated in the flow during crystallization. Two different samples of the surface of the Bluewater flow were collected for helium-3 dating. These samples yielded an average age of 57 ± 6 ka; a third sample of the flow was dated by the uranium-series method, yielding an age of 79 ± 40 ka. The ages obtained by the two different methods agree within experimental error.

The Bandera flows were erupted from Bandera Crater, which lies within El Malpais NM about 40 km southwest of Grants, New Mexico. With the assistance of the NPS, a backhoe was used to excavate trenches through scoria erupted from the volcano. Two samples of charcoal for radiocarbon dating were collected from the soil immediately below the scoria. This charcoal probably represents roots burned from the heat of the scoria eruption. These samples gave ages of 10,050-10,070 and 10,990 calibrated years before present (B.P.). We believe that the older age is more likely to be correct. Three samples of the Bandera flow were dated using the helium-3 method giving ages of $11,000 \pm 1,100$, $10,000 \pm 1,800$, $12,500 \pm 1,400$ years. We consider the agreement between these methods to be exceptionally good. Work is now in progress on the argon-argon dating.

The McCartys flow, the youngest flow within the Monument, was also dated by both the radiocarbon and helium-3 methods. A site was found on the eastern edge of McCartys flow where stream erosion had cut beneath the flow. Two charcoal samples, representing burnt plant roots, were collected for radiocarbon dating from beneath the flow.

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The youngest pulse of volcanic activity at El Malpais National Monument about 3,000 years ago produced the McCartys flow, shown here overlying the approximately 80,000 year old Laguna flow.



These two samples gave an average age of $2,987 \pm 92$ calibrated years B.P. Two samples of the surface of McCartys flow were dated by the helium-3 method. These samples gave ages of $2,500 \pm 1,100$ and $2,400 \pm 600$ years. Again we consider the agreement between methods to be excellent.

The results of our third geochronological study were presented at a geochronology field conference held in Grants, New Mexico in April, 1993. This conference was hosted by Los Alamos National Laboratory, New Mexico Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and

Technology, and the NPS. In attendance were 55 geochronologists and geomorphologists from the U. S. and Canada. Considerable interest was expressed by the participants in developing El Malpais NM as a test area for new dating techniques. A large number of samples were collected during the conference for cosmogenic carbon, chlorine-36, and thermoluminescence dating and paleomagnetic studies. Results of these studies will be reported to the NPS on an annual basis.

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Bandera Crater (left center, by the highway) can be seen here together with several other cinder cones that lie within El Malpais National Monument.

