



## **$^{40}\text{Ar}/^{39}\text{Ar}$ dating of the Valsequillo volcanic deposits, Central Mexico: Resolution of an ongoing archaeological controversy and implications for the first human colonization of the 'New World'**

Darren Mark

Scottish Universities Environmental Research Centre, NERC Argon Isotope Facility, East Kilbride, United Kingdom  
(d.mark@suerc.gla.ac.uk)

It is currently accepted that the Clovis culture was the first to migrate into the New World at 13.1 ka [1]. However, archeological evidence in the form of stone tools, linguistics, craniometrics and genetics suggest that the first Americans were ethnically diverse and a few sites dated to 15-16 ka BP challenge the 'Clovis First' model. Perhaps the biggest challenge to the 'Clovis First' model was the reported presence of human footprints within a basaltic ash (Xalnene Ash) dated to  $38.04 \pm 8.57$  ka using optically stimulated luminescence (OSL) [2]. However, Renne et al. [3] challenged the validity of the footprints by dating lapilli from the Xalnene ash using  $^{40}\text{Ar}/^{39}\text{Ar}$  and reported an age of  $1.30 \pm 0.03$  Ma ( $2\sigma$ ). They also reported a reversed palaeomagnetic polarity for the ash, consistent with deposition during chron C1r.2r. Such antiquity casts considerable doubt on the interpretation of the impressions as human footprints. Gonzalez et al. [4] questioned the validity of the  $^{40}\text{Ar}/^{39}\text{Ar}$  age and highlighted the heterogeneous nature of the lapilli as a potential problem for  $^{40}\text{Ar}/^{39}\text{Ar}$  geochronology. The lapilli contain abundant phenocrysts and xenocrysts. Olivine phenocrysts can be contaminated with excess Ar ( $^{40}\text{Ar}_E$ ) [5] and hence the dating of  $^{40}\text{Ar}_E$ -bearing lapilli and xenocrystic material may potentially produce anomalously old  $^{40}\text{Ar}/^{39}\text{Ar}$  ages. Gonzalez et al. [4] also dismissed the significance of the reversed palaeomagnetic polarity as the proposed age of the ash ( $38.04 \pm 8.57$  ka) overlapped with the Laschamp Geomagnetic Excursion at  $40.4 \pm 1.1$  ka.

Subsequently there has been support for both sides of the debate. The OSL age presented was questioned [6] and reconfirmed by [7]. The OU  $^{40}\text{Ar}/^{39}\text{Ar}$  laboratory showed the presence of  $^{40}\text{Ar}_E$  in the samples although they were unable to date the ash [2]. Palaeomagnetic data has both supported emplacement of the Xalnene Ash during the LGE [8,9] and at 1.3 Ma [10]. The age of the 'alleged' footprint-bearing Xalnene ash and hence the timing of the first human colonization of the Americas remain highly controversial.

New  $^{40}\text{Ar}/^{39}\text{Ar}$  ages for basaltic lava flows and silicic tuffs throughout the Valsequillo stratigraphic sequence resolve the ongoing archaeological controversy. The data have direct implications for the first human colonization of the 'New World'.

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