3.61 ± 0.13 Myr result on the least altered material is a reasonable minimum age. If the KMB-B age turns out to be too high then the K/Ar data indicate that this flow is unusual, having both extraneous $^{40}Ar^*$ and alteration.

(2) Volcanic glass from separate eruptions of large caldera collapse centres can have very similar chemistries, although separated in eruption by several hundred thousand years. For example, the 2.0-Myr and 0.6-Myr eruptions of Yellowstone (USA) match the similarity of SHT and Tulu Bor using more elements than Brown did[5–8]. Ultimately only primary geochronology could distinguish between these tuffs[9]. Brown provides strong evidence that SHT and Tulu Bor are from the same magma sources, but whether they are also from the same eruption remains inconclusive.

Considering the rift basin setting of SHT and Tulu Bor, 900 km apart, ash from this large magnitude eruption should be preserved somewhere between the two sites. Establishing correlations in the inter-basin area will confirm the SHT–Tulu Bor correlation whereas if two stratigraphically distinct, but chemically similar, tuffs are found, it will be necessary to reject it.

(3) An unusual criterion of SHT should be sought at Turkana. Stratigraphically superjacent to SHT is a volcanoclastic sand, rich in sanidine (mode = 15%) compared with uncommon K-feldspar in typical Hadar sands (mode = 0.6–1.2%). The bulk of this sand's sanidine produces concordant ages at 9.00 ± 0.14 Myr (new constants) despite a range in K_2O from 3.9 to 7.4% (ref. 10). Did the SHT eruption disperse an old pre-existing roof from the volcanic centre?

(4) If SHT and Tulu Bor do correlate another possibility is that our older age structure for Hadar, based on KMB-B and BKT-2, is more appropriate than that proposed by Brown for Turkana, which is heavily weighted by magnetic stratigraphy. Most K/Ar data for the lower Omo and East Turkana sections have been imprecise, except for Shungura B-10, the K/Ar date of which Brown rejects as too old. Palaeomagnetic stratigraphy is part of the overall criteria to establish age but, alone, is prone to errors in polarity and in recognizing whether disconformities have lost reversals. As with the KBS tuff, further geochronology should resolve which age framework is right, and whether SHT and Tulu Bor correlate.

We are pleased by Brown's discovery that the same volcanic centre probably shed ash, perhaps in the same eruption, to both the Awash and Turkana Basins. Faunal records from both basins are largely complementary. Establishing the same tephra time-plane across both basins would represent a fortunate circumstance for understanding East African faunal evolution. We need to locate the source volcano that could have produced a voluminous SHT–Tulu Bor ash, and unravel its eruptive history. These hypotheses are testable and point out the difficulties in accepting *a priori* Brown's correlation.

We thank G. A. Izett, A. Sarna-Wojcicki and J. A. Westgate for unpublished data on North American caldera eruptions.

J. L. Aronson
Department of Geological Sciences, Case Western Reserve University, Cleveland, Ohio 44106, USA

R. C. Walter
Department of Geology and Geophysics, University of Toronto, Toronto, Ontario, Canada M5S 1A1.

M. Taieb
Laboratoire de Géologie du Quaternaire, Centre Nationale de la Recherche Scientifique, 132 88 Marseille, Cedex 2, France

1. Brown, F. *Nature* **300,** 631–633 (1982).
2. Walter, R. C. & Aronson, J. L. *Nature* **296,** 122–127 (1982).
3. Aronson, J. L. *et al. Nature* **267,** 323–327 (1977).
4. Walter, R. C. thesis, Case Western Reserve Univ. (1980).
5. Izett, G. A. *J. geophys. Res.* **86,** 10200–10222 (1981).
6. Izett, G. A. *US geol. Surv.* Open File Rep. 82-582, 44 (1982).
7. Sarna-Wojcicki, A. M. *et al. US geol. Surv.* Open File Rep. 80–231 (1980).
8. Westgate, J. A., Christiansen, E. A. & Boellstorff, J. D. *Can. J. Earth Sci.* **14,** 357–374 (1977).
9. Naeser, C. W., Izett, G. A. & Wilcox, R. E. *Geology* **1,** 187–189 (1973).
10. Aronson, J. L., Walter, R. C., Taieb, M. & Naeser, C. W. *Proc. 8th Panafrican Congr. of Prehistory and Quat. Studies, Nairobi, 1977,* 47–52 (1980).

Brown replies—There are two separate issues addressed above—correlation and chronology. I agree that geochemical correlation is permissive, but, as noted earlier, the magnetic polarity record and faunal data[1,2] also support the correlation. I have recently determined that the SHT contains about 5% of shards which correspond to the α-Tulu Bor composition. This is also characteristic of the β-Tulu Bor[3], hence I believe the correlation is secure. Note that the Tulu Bor Tuff (70 samples) is compositionally quite distinct from 110 other tuffs in the Turkana Basin (475 samples), and is unusual for East African silicic volcanics in general.

The distribution of the Tulu Bor and/or SHT tuffs does not necessarily imply an excessively large eruption. In both cases the tuffs are water-deposited from rivers[4,5]. It may only be necessary that ash was supplied to the upper reaches of the Awash and Omo rivers, which have a common drainage divide.

Concerning the chronology, both parties agree that the SHT and Tulu Bor Tuffs are between 3.2 and 4 Myr old, and of normal polarity[6]. There are thus two possible placements—3.17–3.41 Myr (bottom of Gauss Chron) or 3.82–3.92 Myr (Cochiti Subchron). The magnetostratigraphy in section A[7] at Hadar, and in the Turkana Basin, favours the younger placement. The older placement requires slow sedimentation rates in the stratigraphic interval between the Tulu Bor and the next highest dated horizon, and between the SHT and the bottom of the reversed interval identified as the Mammoth Subchron in Section A[7]. Alternatively, disconformities might exist in both sections in this interval, but none has been documented. Still, the earlier placement cannot be categorically denied given the poor radiometric control on the earlier part of the Turkana sequence at present.

The older placement is favoured by the age on the type B KMB of 3.61 Myr, only provided that age is meaningful and the KMB is placed correctly in the section. I admit missing the footnote[6] which equates KM-1-74(lab) with KM-2-74. Acceptance of 3.61 Myr as a minimum age on KMB depends strongly on petrographic arguments, thus I find it peculiar that the mix-up was not dealt with in the revised data[8], especially as KM-1-74 had been discussed previously[7] as type A-1 and KM-2-74 as type A-2. Even so, type A-1 KMB sometimes yields ages older than expected, and type B KMB sometimes yields ages younger than expected[8]. The reason for this is unclear; the reported inverse correlation of age with glass content in type A-1 (ref. 8) is very weak.

The Hadar faunas are more securely related to the SHT than to the KMB (Fig. 2 of ref. 5). Placement of the KMB in the Hadar section has been difficult. It seems possible that the KMB caps an older sedimentary sequence separated from the main Hadar sequence by an unconformity. This possibility might explain the difficulty in tracing beds below the basalt into the main Hadar sequence (see Fig. 4 of ref. 9 and Figs 34:3 and 34:4 of ref. 5). Aronson, Walter, Taieb and Tiercelin considered the possibility of the Kadada Moumou Plateau as a horst, but rejected this in favour of a minor intraformational unconformity above KMB (J. Aronson, personal communication).

Francis H. Brown
Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112, USA

1. Boaz, N. T., Howell, F. C. & McCrossin, M. L. *Nature* **300,** 633–635 (1982).
2. Cooke, H. B. S. *Kirtlandia* **29,** 1–63 (1978).
3. Cerling, T. E. & Brown, F. H. *Nature* **299,** 216–221 (1982).
4. Brown, F. H. *Calibration of Hominoid Evolution* (eds Bishop, W. W. & Miller, J. A.) 273–287 (Scottish Academic, Edinburgh, 1972).
5. Johanson, D. C., Taieb, M., Gray, B. T. & Coppens, Y. *Geological Background to Fossil Man* (ed. Bishop, W. W.) 549–564 (Scottish Academic, Edinburgh, 1978).
6. Walter, R. C. thesis, Case Western Reserve Univ. (1980).
7. Aronson, J. L. *et al. Nature* **267,** 323–327 (1977).
8. Walter, R. C. & Aronson, J. L. *Nature* **296,** 122–127 (1982).
9. Taieb, M., Johanson, D. C., Coppens, Y. & Aronson, J. L. *Nature* **260,** 289–293 (1976).