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Discussion

Reply to: Comments on "Trace element and isotopic evidence for Archean basement in the Lonar crater impact breccia, Deccan volcanic province" by Ramananda Chakrabarti and Asish R. Basu

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Misra [1] has strong reservations on our finding of Archean crustal signatures in the Lonar crater impact breccia. Our inference was based on textural, mineralogical, trace element and Nd, Sr, Pb isotopic analyses of the target basalts and the impact breccia rocks of the crater [2], whereas Misra's arguments are based on the non-*in situ* nature of some of the impact breccia samples of the crater included in our study. It should be noted that he provided all the samples for our study that he also used in a recent study [3]. He now argues that some of the impact breccia samples of our study as well as his might be contaminated with "artificially made bricks". This assessment, it should be noted, was neither mentioned to us when Misra provided the samples nor included in his recent paper [3] that he co-authored with S. Osae, C. Koeberl, D. Sengupta and S. Ghosh.

We do not agree with Misra's interpretation that the geochemical data of the Lonar impact breccia were affected by anthropogenic contamination. To confirm our earlier conclusion, we provide additional Pb-isotopic data here from two new *in situ* impact breccia samples collected by one of us (Ghatak) in June 2006. The precise (GPS) locations of these samples (Fig. 1) along with their Pb-isotopic compositions are given in Table 1. The

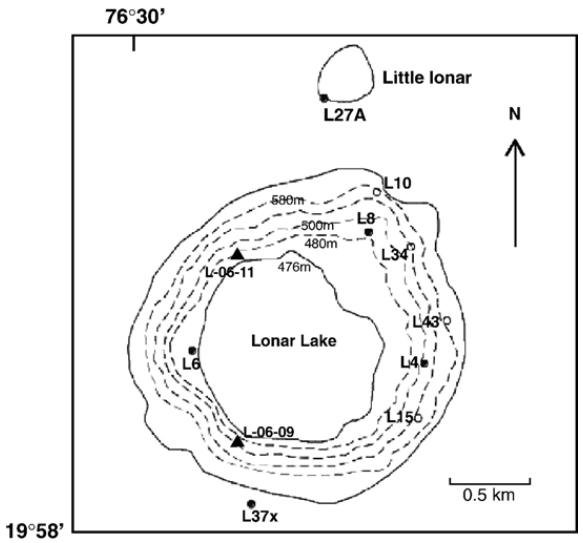

Fig. 1. Locations of the impact breccia (filled circles) and host basalt samples (open circles) from the Lonar impact crater in the Deccan volcanic province, India (from [2]). Also, shown are the locations of the two *in situ* impact breccia samples (filled triangles) collected recently (June, 2006) by one of us, that show similar Pb-isotopic compositions as the breccia samples of our published report, but distinctly different from the Lonar *in situ* target basalts of (see Fig. 2) our earlier study [2].

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Pb-data are also plotted along with our previous data [2] in Fig. 2. The Pb-isotopic compositions of these new *in situ* breccia samples overlap with those of the *in situ* as well as non-*in situ* breccia samples of our earlier study (Fig. 2). Thus, the high $^{207}Pb/^{204}Pb$ at low $^{206}Pb/^{204}Pb$ of these new samples cannot be from "artificially made bricks". The new data are consistent with the interpretation for an Archean crustal component in these rocks.

We have again examined all seven breccia samples of both *in situ* and non-*in situ* provenance of the Lonar crater petrographically, and find them similar without any trace of anthropogenic components. Our microscopic observations of the 7 breccia samples are similar to those shown in the photomicrographs of our paper in [2]. They clearly demonstrate the presence of impact spherules and provide evidence of melts in the impact breccia. In addition, these breccia are massive, compact rocks with clasts of the host basalts in them with no evidence whatsoever of any exogenous clay material. We, therefore, disagree with Misra's assertion that certain non-*in situ* impact breccia rocks of our study were "earthen bricks" used for construction of ancient temples around Lonar and had a "possible foreign provenance".

The fact that the *in situ* and non-*in situ* breccia are identical in their major and trace element as well as Nd, Sr, Pb isotopic compositions clearly supports our contention regarding their common geochemical inheritance of an Archean component. This geochemical similarity was also noted by Misra and co-workers in their study of the same set of samples (see [3], p. 1490) without the isotopic data, of course. It is surprising that Misra now mentions subtle differences in the average concentrations of selected major and trace elements between the *in situ* and non-*in situ* Lonar breccia (Table 1 in [1]). We believe that these differences between the *in situ* and non-*in situ* breccia are not substantial, especially when the two breccia-types are similar petrographically, isotopically and also in most of their trace and major element concentrations.

Based on the above arguments, especially the petrographic and mineralogical observation and the new Pb isotopic data of *in situ* samples collected by us, we strongly refute the comments made by Misra and firmly support our earlier conclusion regarding the evidence of an Archean geochemical imprint in the Lonar impact breccia.

Table 1
GPS location details and Pb isotopic compositions of two new *in situ* impact breccia samples collected in June, 2006 by one of us from the Lonar crater

Sample no.	Location	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$
L06-09	N19°58′18.6″ E76°30′44.0″	18.476	15.727	38.803
L06-11	N19°58′56.3″ E76°30′46.9″	18.605	15.681	38.787

The Pb isotopic composition of these two samples overlaps with those of both *in situ* and non-*in situ* breccia samples of our earlier report [2].

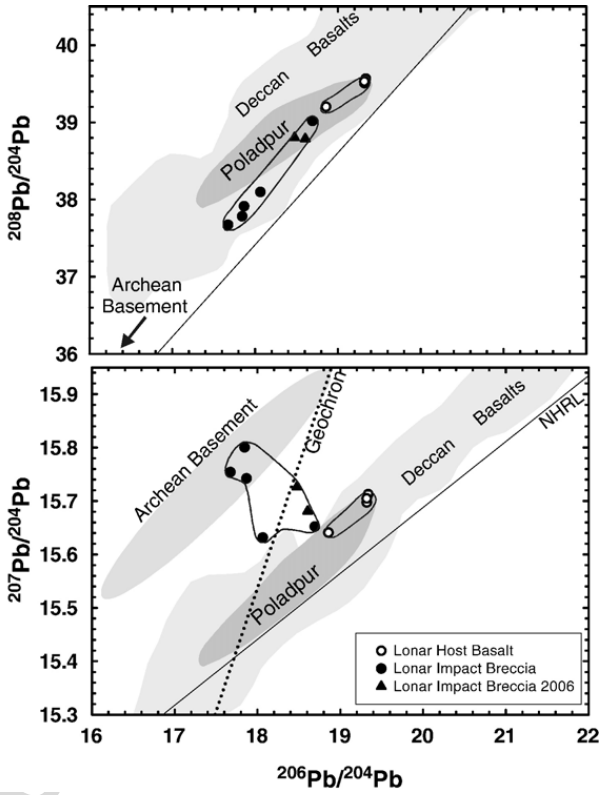

Fig. 2. The Pb-isotopic composition of two *in situ* impact breccia samples (filled triangles) collected by one of us in June, 2006 from the Lonar crater is similar to those of the *in situ* and non-*in situ* impact breccia samples from our earlier study [2], indicating that there is no anthropogenic contribution of Pb in the non-*in situ* samples as claimed by Misra [1]. These new breccia samples also show a high $^{207}Pb/^{204}Pb$ at low $^{206}Pb/^{204}Pb$ indicating involvement of an Archean component during the formation of the breccia upon impact.

References

[1] S. Misra, Comments on the paper 'Trace element and isotopic evidence for Archean basement in the Lonar crater impact breccia, Deccan volcanic province' by Ramananda Chakrabarti and Asish R. Basu in Earth and Planetary Science Letters 247 (2006) 197–211., Earth Planet. Sci. Lett. (2006-this issue), doi:10.1016/j.epsl.2006.08.018.

[2] R. Chakrabarti, A.R. Basu, Trace element and isotopic evidence for Archean basement in the Lonar crater impact breccia, Deccan volcanic province, Earth Planet. Sci. Lett. 247 (2006) 197–211.

[3] S. Osae, S. Misra, C. Koeberl, D. Sengupta, S. Ghosh, Target rocks, impact-glasses and melt rocks from the Lonar impact crater, India: morphology, petrography and geochemistry, Meteorit. Planet. Sci. 40 (2005) 1473–1492.