

Hypothetical source crater for Australasian tektites: Moving from Indochina to Northwest China?

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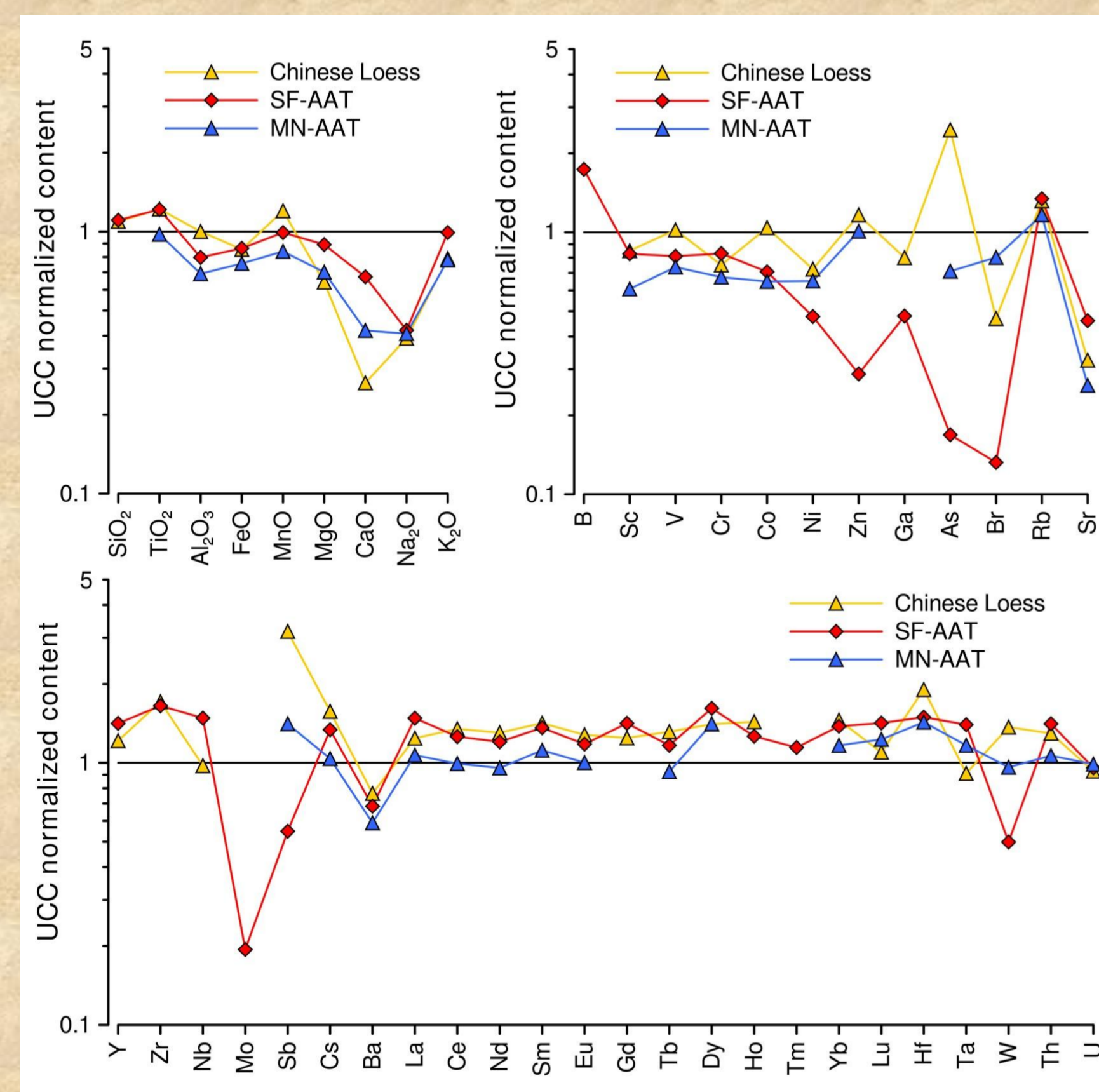
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Summary

A source crater for Australasian tektites (AAT), the largest tektite group in terms of the quantity recovered and the strewn field area, has not been found so far. We have argued against the generally accepted hypothetical location of the crater in Southeast Asia (Indochina) and presented an alternate hypothesis of a possible location of the AAT source crater in deserts of Northwest China [1]. This hypothesis is based mainly on striking geochemical similarities between AAT and Chinese loess (CL) and its precursors, including Sr and Nd isotopes. Other supporting evidence is provided by the unique geological setting of the suggested target area. The current work justifies the hypothesis introduced in [1], and supplements it with new supporting evidence based on the global gravity data in the suggested target area.

Geochemical similarity of AAT and Chinese loess

AAT suite from various parts of the strewn field (15 SF, 16 ASF, 3 MN) analyzed by instrumental neutron and photon activation analyses. Average geochemical composition of AAT has been compared with composition of Chinese loess (CL) (Taylor1983 in [1]). Except for lower levels of Zn, Ga, As, Br, and Sb probably volatilized during the tektite formation process, compositions of AAT and CL are virtually identical regarding variability of loess and analytical uncertainty.



Arguments against AAT parent crater in Indochina

In Indochina, with prevalence of chemically weathered sediments (laterite), the presence of suitable loess-like materials has not been documented. Reported loess-like layer is much younger than AAT.

Suggested offshore crater locations may be ruled out by geochemical and isotopic compositions of AAT, lacking signs of a marine environment.

Location of a parent crater directly inside the main part of the strewn field, based on the distribution of layered AAT, lacks analogy with other tektite strewn fields, where tektites are always distant from known source craters.

The fact that a large impact structure has not been discovered in a thoroughly explored and exploited area also makes the location quite improbable.

Australasian tektites (AAT)

Tektites are glasses produced during a hypervelocity impact of a large extraterrestrial body by melting surface terrestrial materials and ejecting the melt far to a distant strewn field (distal ejecta).

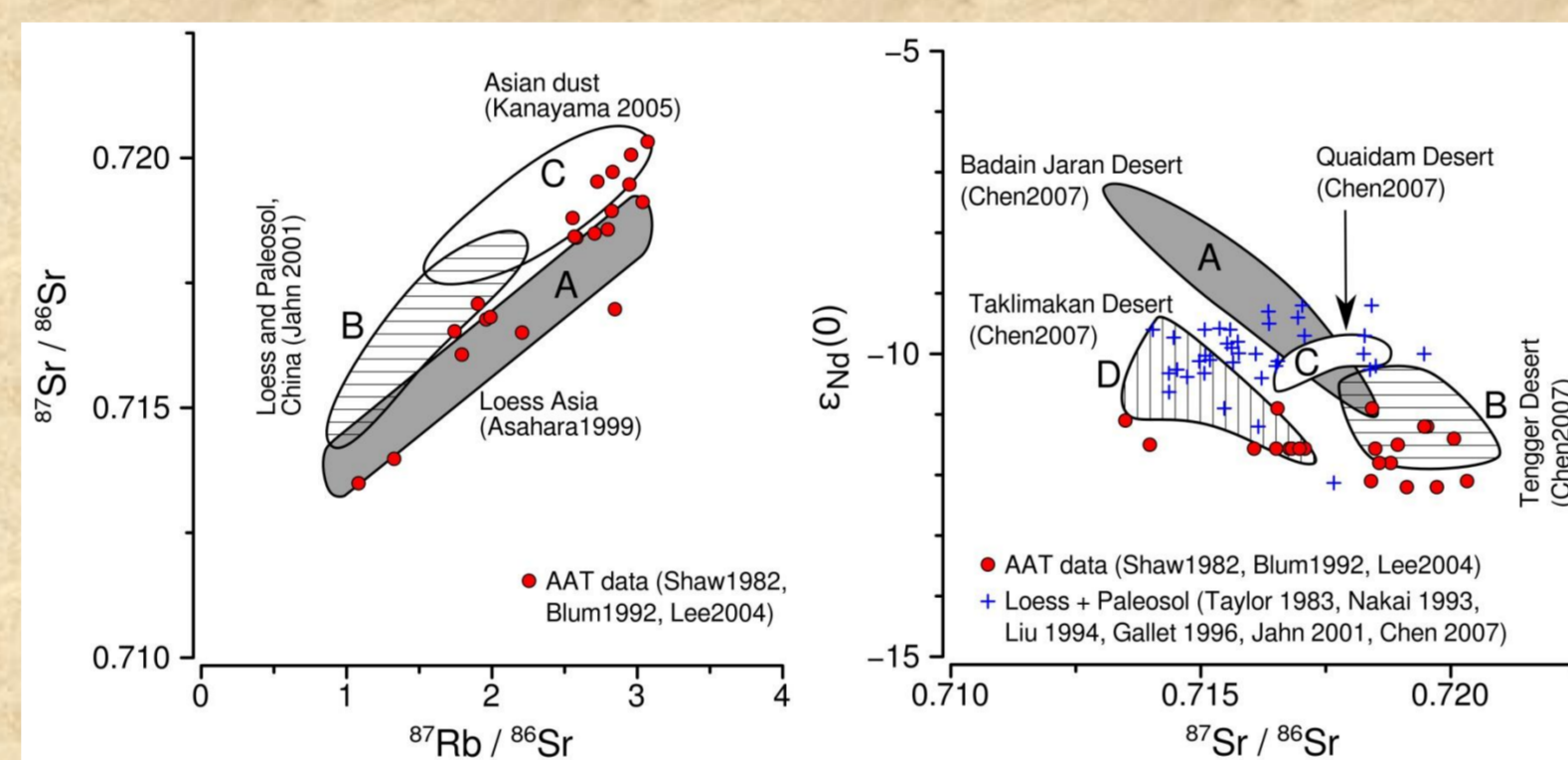
AAT (age 0.8 Ma) form the largest known tektite strewn field. Location of the AAT parent crater is unknown. It has been proposed in Indochina. AAT geochemical composition implies their origin from typical upper continental crust (UCC) materials, particularly loess.

AAT morphology: splash and splat-forms (SF); aerodynamically shaped ablated splash-form (ASF; flanged button australites); layered Muong Nong (MN) - large (up to tens of kg), heterogeneous.



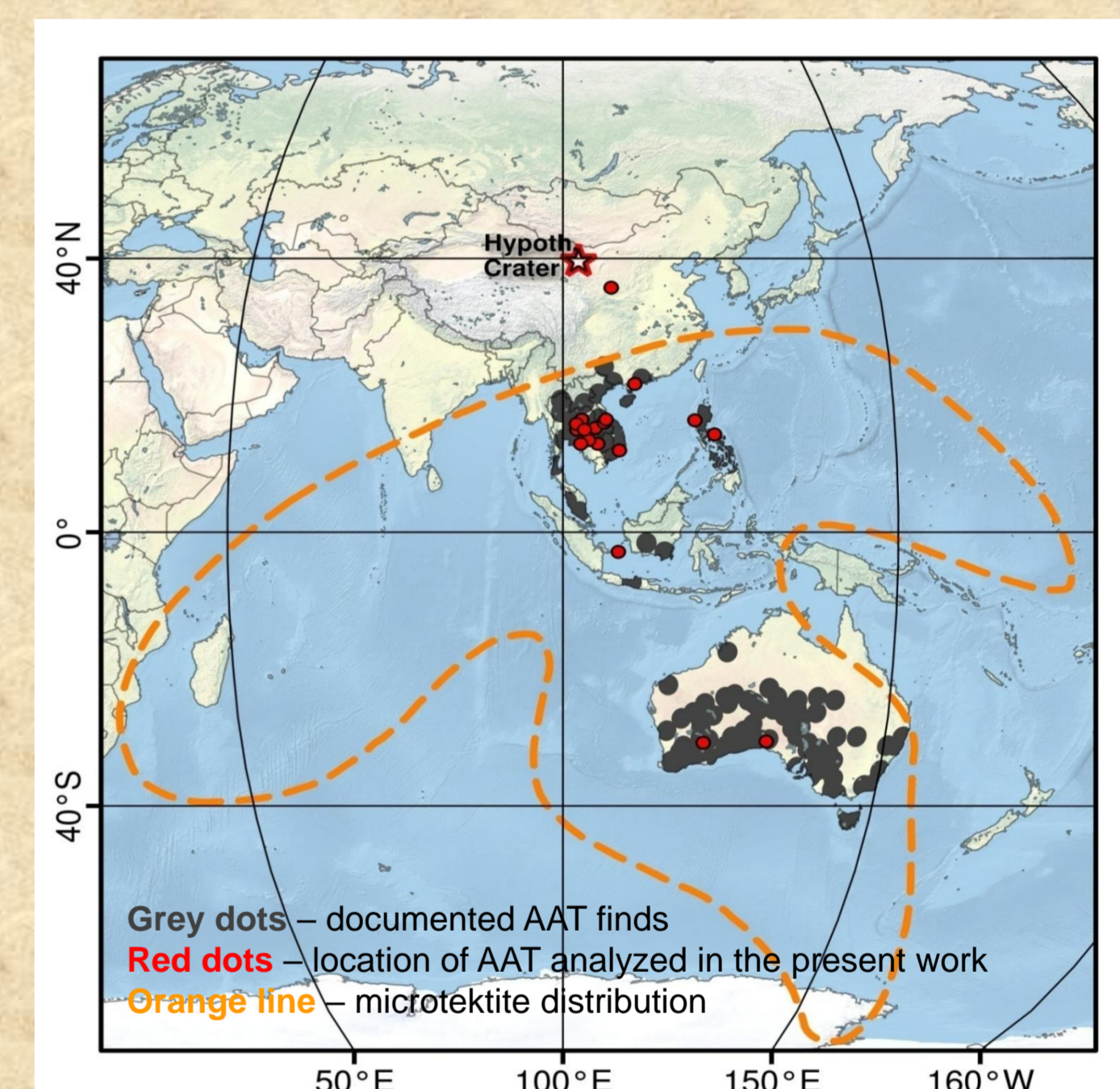
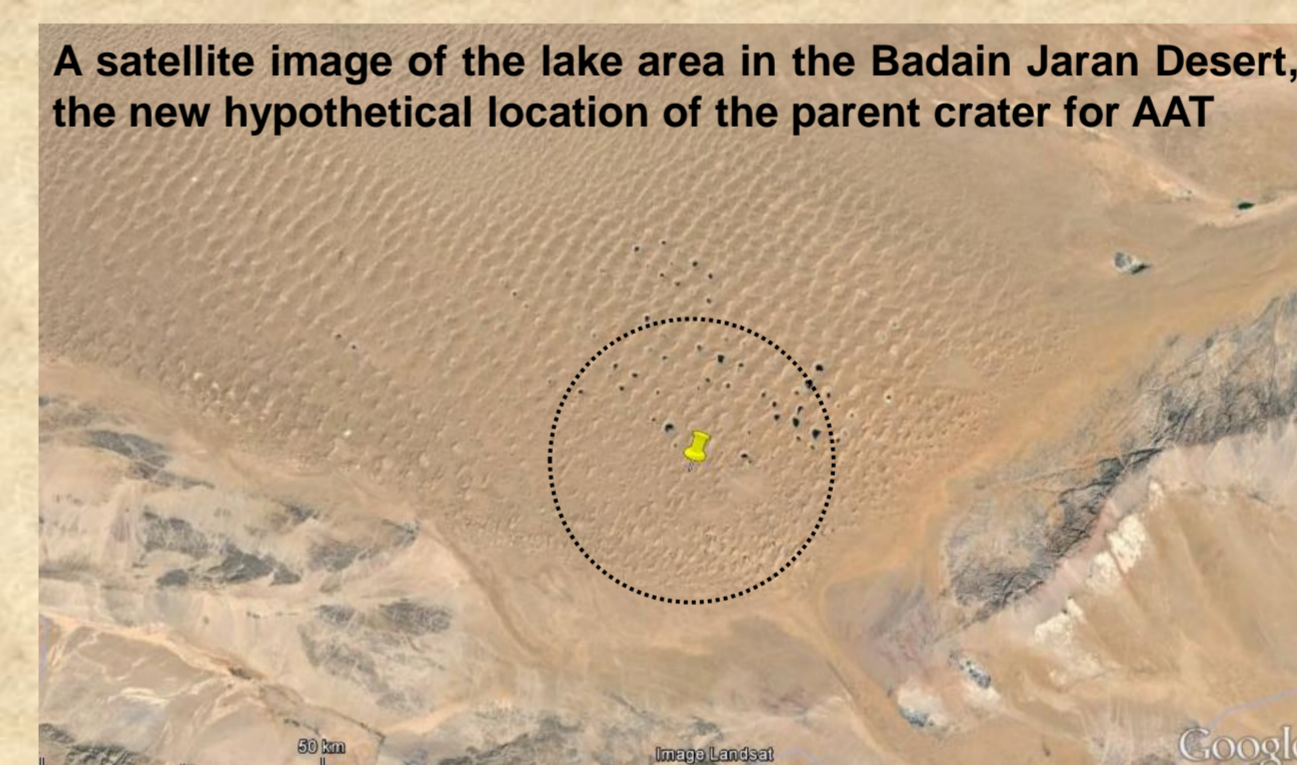
Isotopic similarity of AAT and precursors of Chinese loess

Variations in the Sr-Nd isotopes in AAT match those observed in CL or its precursors - aeolian sands in deserts located in Northwest China ([1] and references therein). The isotopic variations in AAT may be mostly due to variable proportions of silicate and carbonate fractions in the source materials, and reflect stratigraphic history of the target area as a result of local and global climatic changes (glacial/interglacial cycles) and aeolian processes. Also contents of the cosmogenic nuclide ¹⁰Be, and Li and B isotopes in AAT and CL are consistent.



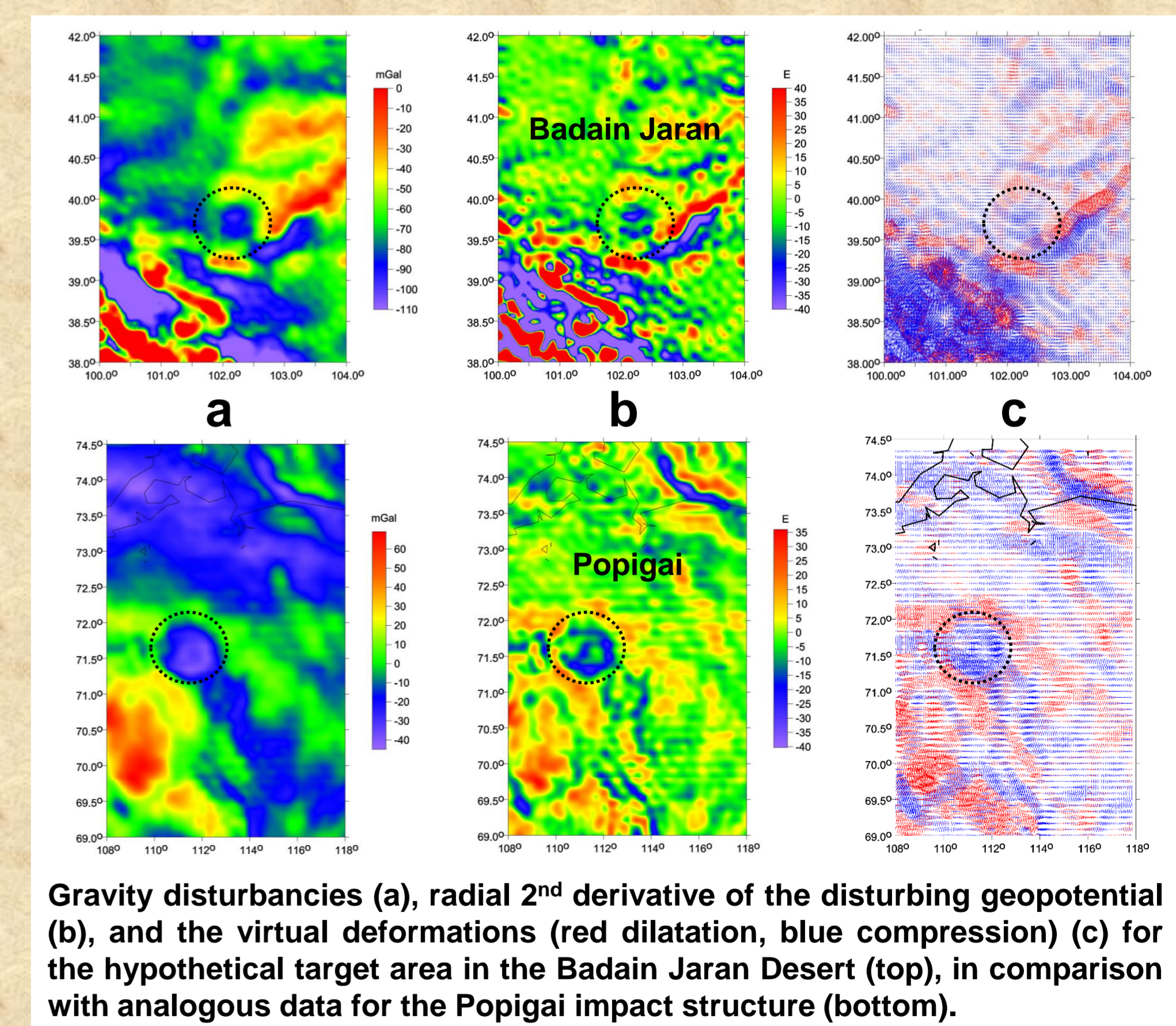
New hypothetical location of AAT parent crater

An impact into the Badain Jaran Desert would meet conditions of sufficient supply of suitable source materials for AAT and burial of the crater under sand megadunes, tall up to hundreds of meters. Unique geological features of the area, namely formation and maintenance of the megadunes and lakes with tufa similar to that formed after the Ries impact, could be partially attributed to post-impact effects.



Contribution of global gravity data

Inspection of the gravity data in the hypothetical target area included besides the ordinary gravity anomalies (disturbances) also the full Marussi tensor of the 2nd derivatives of the disturbing geopotential, gravity invariants, their specific ratio, the strike angle and virtual deformations [2]. It employed the latest combined global gravity field model EIGEN-6C4 [3]. The gravity data show the existence of a circular structure centered at 39.7°N, 102.2°E, covering roughly the lake area in the Badain Jaran Desert. The structure is characterized by a negative gravity anomaly of about -100 mGal with a diameter <50 km, surrounded by a fragmented rim with a pronounced positive gravity anomaly, of diameter ≈100 km. The 2nd radial derivative shows minima and a fragmented rim, and virtual deformations exhibit a strong compression trend. Analogous data for the Popigai impact structure are shown for comparison.



Conclusions

Moving the currently accepted hypothetical location of the AAT source crater from Indochina to deserts of NW China would not change dramatically current model considerations and interpretations, such as distribution of various morphological and constitutional AAT types, microtektites and unmelted ejecta. The new location better meets conditions of sufficient supply of compositionally suitable source material and filling and burial of the crater. Intensive investigations in the proposed target area, including a search for shock metamorphic features, are needed to confirm or disprove the hypothesis.

References

- [1] Mizera J. et al. 2016. *Earth-Sci Rev* 154:123–137.
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- [3] Förste C. et al. 2014. *Geophys Res Abstr* 16:EGU2014-3707.

Acknowledgments

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