

Sturtian snowball Earth triggered by a widespread magmatic province and thoughts on a possible mid-Sturtian glacial retreat

KAILU¹, ROSS N MITCHELL^{2,3}, XIAN-HUA LI^{1,2} AND XU LIU^{1,2}

¹Institute of Geology and Geophysics, Chinese Academy of Sciences

²College of Earth and Planetary Sciences, University of Chinese Academy of Sciences

³Chinese Academy of Sciences (CAS)

Presenting Author: lukai@mail.iggcas.ac.cn

The ca. 717–661 Ma Sturtian glaciation represents the first Neoproterozoic snowball Earth. Here we report that Franklin-aged magmatism was present not only in Laurentia and Siberia, but also in South China, where the Hubei–Shaanxi Magmatic Province formed at 720 Ma, revealing widespread magmatic provinces immediately preceding initiation of the Sturtian snowball Earth. This widespread volcanism across supercontinent Rodinia, extending from tropical to temperate latitudes, started at ca. 720 Ma and lasted until the ca. 717 Ma Sturtian onset. The widely distributed, coeval volcanism could be related to a mantle superplume beneath Rodinia. Such rapid and widespread volcanism may have triggered the Sturtian glaciation^[1]. Then, after the Sturtian was underway, geological evidence from five continents suggests a possible mid-Sturtian glacial retreat, which happens to coincide with two asteroid impacts, the ca. 687 ± 5 Ma Jänisjärvi (Baltica) and 657 ± 43 Ma Strangways (Australia) impact craters. The coincidence between the impact and glacial retreat has inspired a “snowball impact” hypothesis that greenhouse warming caused by the impact-generated vaporization of sea ice could have driven temporary, localized glacial retreat^[2]. An impact during snowball Earth—penetrating a massively thick ice sheet—provides an opportunity to look for evidence of large scale vaporization of the ice sheet. Our preliminary NanoSIMS analysis of the water contents of impact melt rocks from the ca. 687 Ma Jänisjärvi impact crater demonstrates extremely high water contents (up to several tens of thousands ppm), indicating the existence of impact-generated hydrothermal systems and possible impact-generated glacial meltwater input. Such extremely high water contents record in the impact melt rocks potentially support the “snowball impact” hypothesis. However, further investigations are required to confirm this.

References

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