Earth's Oldset Preserved Impact Structure - Yarrabubba, Western Australia

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The ~70 km-diameter, deeply eroded Yarrabubba impact structure in Western Australia has previously been regarded as Proterozoic. New *in situ* U-Pb data from zircon and monazite that recrystallized during impact-driven shock metamorphism at Yarrabubba precisely define the impact age. We present geochronology from shock deformed zircon and monazite from the Yarrabubba monzogranite, the target rock at Yarrabubba, and from the Barlangi granophyre impact melt.

Shock deformed zircon grains within the Yarrabubba monzogranite yield an upper intercept age (2σ) of 2626 ± 36 Ma, consistent with magmatic crystallization of Yilgarn granitoids. However, shock recrystallized zircon within the Balrangi Granophyre yields an upper intercept of 2246 ± 17 Ma. Shock recrystallized domains of monazite from both the Yararbubba monzogranite and the Barlangi granophyre yield a similar mean $^{207}Pb/^{206}Pb$ age of 2229 ± 5 Ma, which we interpret as the best estimate of the impact event.

This result establishes Yarrabubba as the oldest recognized impact structure on Earth and extends the terrestrial cratering record back in time by >200 million years. The Yarrabubba impact occurred during the Great Oxidation Event, when Earth's atmosphere and oceans transitioned from anoxic to aerobic conditions due to the proliferation of early photosynthesizing life. Conspicuously, the Yarrabubba impact event coincides with termination of the Huronian glaicaitons, a time when CO_2 drawdown by phototsynthetic organisms had caused widespread cooling and forced Earth's climate into a global icehouse. Our numerical modeling shows that a Yarrabubba-sized impact event into a continental glacier is capable of instantaneously releasing a significant amount of H_2O vapor into the oxygen-poor atmosphere. We therefore postulate that Yarrabubba played a crucial role in regulating Earth's climate and producing clement conditions for early life.