INSIGHTS INTO CHICXULUB'S POST-IMPACT HYDROTHERMAL DYNAMICS: A NUMERICAL APPROACH

Soraya Alfred

ABSTRACT

A hydrothermal system initiated following the hypervelocity impact into the submerged Yucatán platform 66 Ma is regarded as a mechanism for regional ecological rebound following the end-Cretaceous mass extinction via generation of a chemosynthetic ecosystem. In 2016, drilling of Chicxulub's peak ring allowed for the measurement of physical properties such as porosity and permeability for the first time, and the collection of full waveform seismic data. The melt sheet permeability averages $7x10^{-4}$ milli-Darcy (mD) and the overlying suevite (melt-bearing impact breccia) has permeabilities of $1.0x10^{-4}$ mD to $1.2x10^{-1}$ mD. The peak-ring granite is more permeable than overlying layers, ranging from $8.7x10^{-1}$ mD to 1.0 mD. Using these data, we developed a numerical model to constrain the evolution of temperature with time post-impact. Physical properties in our model were assigned using recent measurements and previous iSALE simulation results while geometry was based on seismic profile analysis and prior simulations.

Our simulation results show that the highly permeable Cretaceous sediments are a necessary component of the system as these allow for the transport of fluids to depth and subsequent redistribution throughout the peak-ring granite. The proximity of the granite to the melt sheet also aids convection as the system's main heat source driving fluid transport is the central melt sheet. High rates of convection last for the first tens of thousands of years but stagnate approaching 300 kyrs with an average temperature just above 50°C. Currently, the temperature at a depth of 1335m within the borehole is 67.5°C and thermochronologic measurements suggest temperatures of 70°C to 90°C lasting >10 Myrs. While additional complexities must be incorporated so that the modeled cooling rates more closely align with inferred cooling rates, the fact remains that highly permeable material underlying less permeable material plays a significant role in the system's evolution.

Sean Gulick

Marc Hesse