Deformation and Shock Metamorphism in the Central Uplift of the East Clearwater Lake Impact Structure

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1. Introduction
- The kinematics of complex crater formation are uncertain, particularly in crystalline rocks.
- Comparing geological observations of deformed shocked target rocks with numerical simulations of complex crater collapse can resolve this uncertainty.
- Here, we investigate deformation and shock metamorphism at the East Clearwater Lake impact structure.

2. Case Study: East Clearwater Lake

East Clearwater Lake (Figure 2) is a 460-470 Ma old [2], 22 km diameter complex crater [3]. The West Clearwater Lake impact structure is younger (286.2 +/- 2.2 Ma), and larger than the East Clearwater structure [4]. Drill core data indicates that East Clearwater possesses a central uplift.

3. Methods and Materials

Firstly, core 1-64 was logged, focussing on structural deformation. Secondly, estimates of peak shock pressure were made by petrographic analysis. Shock pressure estimates were made following the method of [5].

Numerical simulations were carried out using the iSALE shock physics code [6].

4. Core Logging and Shock Barometry Results

4.1 Core Logging

Figure 4: Core 1-64 log, with the occurrence of deformation (cataclasites, melt veins/pseudotachylites, and breccias), and shock pressure estimates. Drill core photographs are shown on the right.

Table 1: Shock classification scheme. Based on [7].

5. Discussion and Conclusions

5.1 Discussion

- There is a high variability of shock pressures in the upper 200 m, this is concurrent with a high frequency of deformation. These observations indicate that the size of coherent rock blocks in complex crater formation gets progressively larger away from the point of impact.

5.2 Conclusions

- Compared to West Clearwater, the magnitude of estimated shock pressures is similar, and observed shock pressures attenuate at a similar, or slightly greater rate, at East Clearwater.

6. References


7. Acknowledgments

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Table 2: Summary of all universal-stage results. PDF sets in overlap between (1013) and (1014) were assigned the (1013) orientation. A 5 envelope was used to assign PDFs.

Figure 1: a) Barringer, a simple crater; b) Tycho, a complex central peak crater; c) a schematic cross-section of a complex crater, based on [1].

Figure 2: a) Satellite image of Clearwater Lake. b) Outline map of East Clearwater Lake Red dots indicate the locations of drill cores. Modified from [4]

Figure 3: Two PDF sets in quartz under cross-polarised light.

Figure 4: Comparison of the final shock distributions in numerical simulations of the East and West Clearwater impact events. All parameters (based on [4]), except for the impactor diameter, are constant between the two simulations.

Figure 6: a) Shock attenuation in simulated drill cores with locations indicated on Figure 5, corresponding to drill cores 1-64 (East Clearwater) and 1-63 (West Clearwater). b) Measured shock attenuation in drill cores 1-64 (This study), and 1-63 [4].

- There is a large discrepancy between predicted shock pressures in numerical simulations and observed shock pressures.

Figure 5: Shock attenuation in drill cores 1-64 (East Clearwater) and 1-63 (West Clearwater).