MICRO-RAMAN IMAGING OF HIGH-PRESSURE PHASES IN GUJBA METEORITE: INSIGHT INTO SHOCK METAMORPHISM

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1 INTRODUCTION

The Gujba meteorite, discovered in northern Nigeria in 1984, is classified as a CBa chondrite due to its high metal content (~60%), large metallic clasts, and barred olivine chondrules.

Scientific Importance:

Previous shock metamorphism studies in Gujba have identified polymorphs, including: Wadsleyite - A high-pressure polymorph of high-pressure olivine, Majorite - A high-pressure garnet phase

2 RESEARCH OBJECTIVES

This study applies Raman spectroscopy to:

- Identify high-pressure mineral phases within Gujba
- Determine the range of shock pressures experienced
- Map spatial variations of shock features within the sample

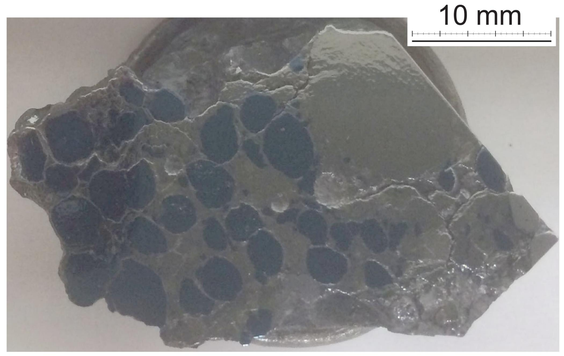

Figure 1: Image of Gujba

3 METHODS

Instrumentation & Spectroscopy

Raman spectroscopy was used to analyze high pressure minerals

Data collected with a WiTec Alpha 500R Confocal Raman Microscope at AMNH

50X objective lens, 532 nm laser, 5 mW power, 300 g/mm grating

Data Collection Approach

Raman spectra were collected from three key regions of Gujba

4 RESULTS

Region 1: Large Barred Olivine Chondrule

- Displays both brittle and plastic deformation, confirming impact-related stress
- Primary minerals: Olivine, enstatite, and minor majorite
- Shock pressure estimate: ~16–18 GPa

Region 2: Chondrule Fragment & Adjacent Matrix

- Wadsleyite detected, indicating shock-induced olivine transformation
- Coexistence of olivine, enstatite, and clinoenstatite
- Estimated shock pressure: 18–20 Gpa

Region 3: Fine-Grained Matrix

- Orthoenstatite & Clinoenstatite identified
- First-time detection of clinoenstatite in Gujba
- Estimated pressure: 8–12 GPa

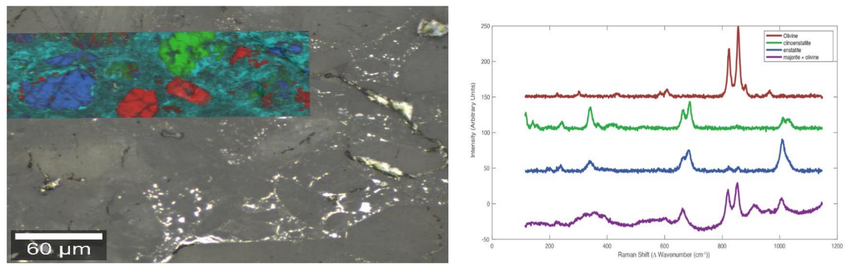

Figure 2: Raman spectral overlays of olivine, enstatite, and majorite

5 DISCUSSION

- Heterogeneous shock effects observed at the micrometer scale
- Wadsleyite is localized, suggesting selective shock transformation zones
- Majorite is inconsistently distributed, implying variable pressure exposure
- Clinoenstatite formation confirms shock pressures of 8–12 GPa, bridging the gap between olivine deformation and wadsleyite transformation

These findings support the hypothesis of an intense planetary-scale impact that led to selective mineral phase transitions within Gujba.

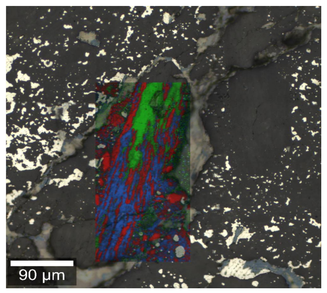

Figure 3: High-pressure mineral phase mapping using Raman imaging

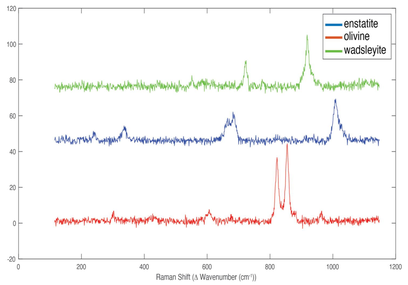

Figure 4: Spectral peaks highlighting key minerals and transformations

6 CONCLUSION

Our study confirms that the Gujba meteorite experienced shock pressures reaching a maximum of ~20 GPa, marking the upper limit of impact-induced pressures observed in this sample. The identification of wadsleyite, majorite, and clinoenstatite highlights complex shock-induced phase transformations, with this being the first report of clinoenstatite in Gujba. The estimated shock pressure range varies between 8–12 GPa and 16–20 GPa, reflecting a small but significant variation rather than a drastic difference. This variability is consistent with localized impact heterogeneity, where different regions of the meteorite experienced slightly different shock conditions. The presence of wadsleyite and majorite in select regions, along with the transformation of enstatite to clinoenstatite, provides valuable insight into the shock history and metamorphic evolution of the Gujba parent body.