THE EFFECT OF GRIND TIME ON THE CRYSTAL LATTICE OF DOLOMITE AND THE IMPLICATIONS FOR SHOCK METAMORPHIC STUDIES OF IMPACTS INTO CARBONATE TARGETS

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Abstract

This study assessed the potential effects of grind times on diffraction peaks in unshocked dolostone samples as a means of providing insight into the problem of sample processing. A sample of the Neoproterozoic Beck Spring Dolomite, Inyo County, CA was cut into 6 aliquots and ground by using a mechanical pulverizer and separately by hand using mortar and pestle in variable grind times (ranging from 3 to 18 minutes) in order to characterize potential variations in X-ray diffraction peaks with grind time.

Diffraction peaks display a trend of decreasing intensity and increasing peak width with increasing grind time for the powders ground with the mechanical pulverizer. There is a decrease in peak height of approximately 62% from the aliquot ground for 3 minutes to the aliquot ground for 18 minutes. This trend is not seen in the aliquots ground using the mortar and pestle.

Introduction

- Impacts from asteroids or comets onto the Earth's surface create shockwaves strong enough to deform the crystal lattice of most minerals. (1)
- Because of their dominance in the Earth's crust, silicates have been the subject of most empirical and experimental shock metamorphic studies.
- Whereas silicates display a wide variety of shock metamorphic textures (e.g. PFs, PDFs, high pressure polymorphs), the response of carbonate minerals are not as diverse and resultant fabrics (twinning, cleavage, and fracturing) are not uniquely generated by shock metamorphism. (2)
- Several previous studies have documented the level of shock-related deformation by noting changes in X-ray diffraction (XRD) patterns in powdered shocked vs. unshocked minerals. (3, 4, 5, and 6)
- Peak broadening: due to shock metamorphism, sample processing, or both?

Hypothesis

- With increased sample processing, the crystal lattice of dolomite will become increasingly deformed
- Effect: If true, this may influence our interpretation of patterns of shock metamorphosed rocks

Methods

- **Sample collection:**
  - Neoproterozoic Beck Springs Dolomite from Inyo County, Ca
  - Beds of light-bluish-grey dolomite, 2 to 4 ft. thick
  - Collected from a natural exposure (no hammer was used)
- **Sample processing:**
  - Sample BS-28 was cut into six, ~3inx2inx.5in pieces (aliquots) for analysis using a Hillquist trim saw
  - Aliquots were then cut into <cm sized pieces in order to eliminate the need to crush the sample using a hammer.
  - For the aliquots ground with the mechanical pulverizer (Angstrom TE 250 ring pulverizer), approximately one third to one half of the amount of pieces from each aliquot were put into the Angstrom model TE 250 ring pulverizer for the appropriate length of time (3, 6, 9, 12, 15, and 18 minutes).
  - After powdering each aliquot, they were run 20 times each in XRD (2Θ of 20^o to 120^o, 15kV, 30mA, scan speed of 2^o/min, and a sampling interval of 0.02^o) in order for a mean to be obtained.
  - A Reitveld peak refinement was done for each aliquot in order to compare the FWHM (full width at half maximum of each peak) values as well.
  - For the aliquots ground by hand using mortar and pestle (silica agate), the same methods were used.

Results

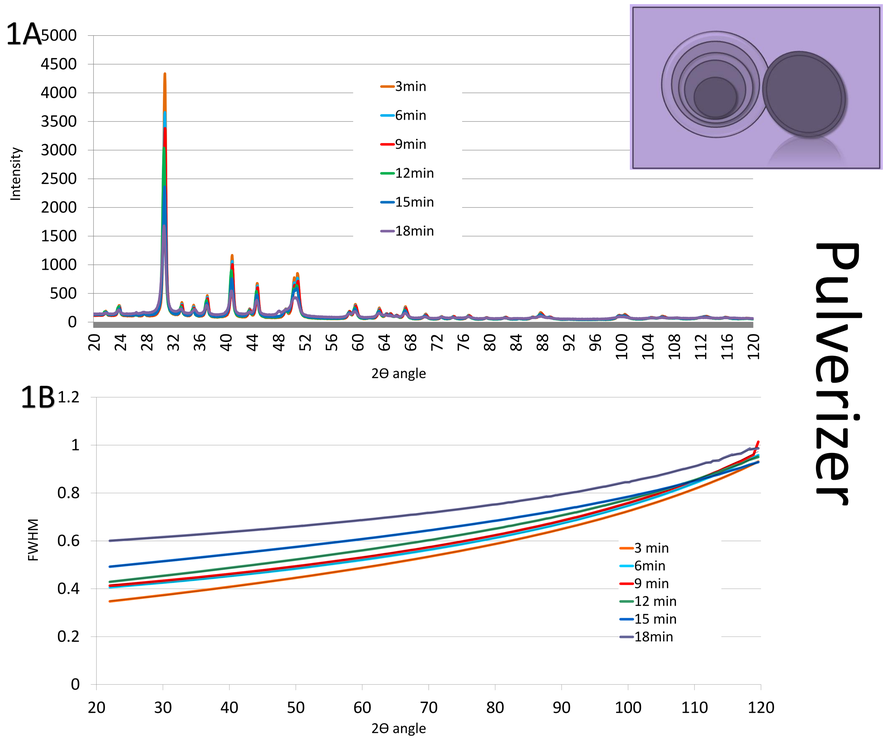

Figure 1:
A.) Mean diffraction patterns for aliquots ground using the mechanical pulverizer B.) Mean FWHM curves for aliquots ground using the mechanical pulverizer

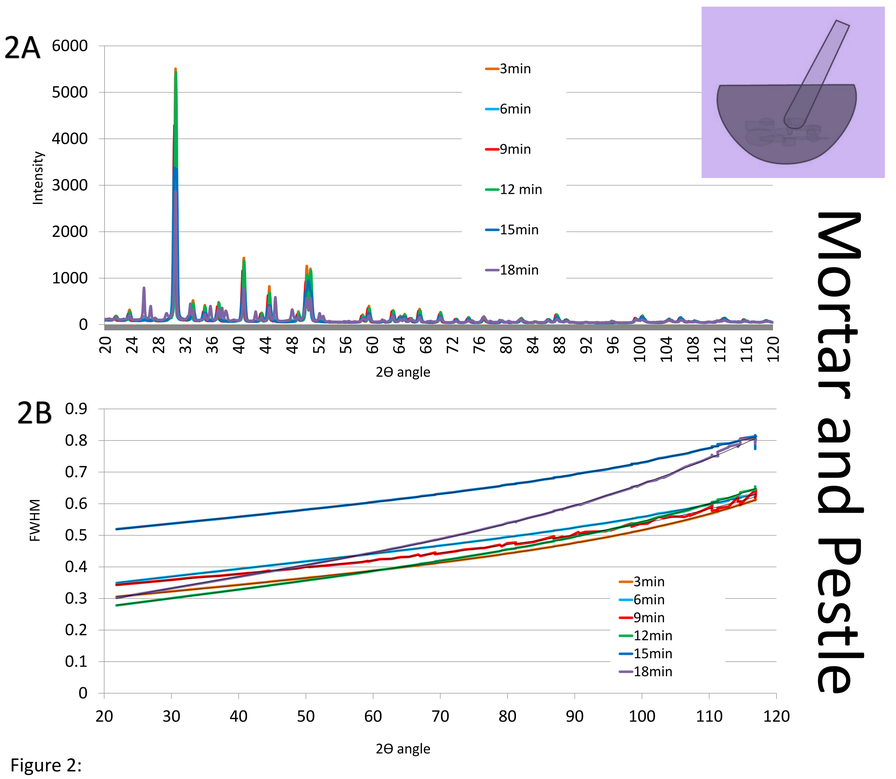

Figure 2:
A.) Mean diffraction patterns for aliquots ground by hand using mortar and pestle B.) Mean FWHM curves for aliquots ground by hand using mortar and pestle

Discussion

- With Increasing processing time…
  - **Mechanical Pulverizer**
    - Systematic increase in peak broadening
    - Decrease in peak intensities (17% per 3min Interval at 2Θ: 31^o, 15% per 3min interval at 2Θ: 41^o, and 13% per 3min interval at 2Θ: 50^o)
  - **Mortar and Pestle**
    - Variable peak broadening and intensities

Conclusions

As seen in the results and discussion, sample processing in the mechanical pulverizer confirms the hypothesis, as a systematic trend is observed with increased grind time.

Sample processing with mortar and pestle does not confirm this hypothesis though, as there is no trend observed through X-ray diffraction analysis.

Figure 3: Image of Beck Springs Dolomite in outcrop with hammer for scale

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