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Jadeite and related species in shocked meteorites: Limitations on inference of shock conditions

Ioannis Baziotis[1,*], Stamatios Xydous[1], Angeliki Papoutsa[1], Jinping Hu[2], Chi Ma[2,†], Stephan Klemme[3], Jasper Berndt[3], Ludovic Ferrière[4,‡], Razvan Caracas[5,6], and Paul D. Asimow[2]

[1]Agricultural University of Athens, Natural Resources Management and Agricultural Engineering, Laboratory of Mineralogy and Geology, Iera Odos 75, 11855, Athens, Greece
[2]California Institute of Technology, Division of Geological and Planetary Sciences, Pasadena, California 91125, U.S.A.
[3]Westfälische Wilhelms-Univ. Münster, Institut für Mineralogie, Correnstrasse 24, 48149 Münster, Germany
[4]Natural History Museum, Burgring 7, A-1010, Vienna, Austria
[5]CNRS, Ecole Normale Supérieure de Lyon, Laboratoire de Géologie de Lyon LGLTPE UMR5276, Centre Blaise Pascal, 46 allée d'Italie Lyon 69364, France
[6]The Center for Earth Evolution and Dynamics (CEED), University of Oslo, Blindern, Oslo, Norway

Abstract

Jadeite is frequently reported in shocked meteorites, displaying a variety of textures and grain sizes that suggest formation by either solid-state transformation or by crystallization from a melt. Sometimes, jadeite has been identified solely on the basis of Raman spectra. Here we argue that additional characterization is needed to confidently identify jadeite and distinguish it from related species. Based on chemical and spectral analysis of three new occurrences, complemented by first-principles calculations, we show that related pyroxenes in the chemical space $(Na)^{M2}(Al)^{M1}(Si_2)^{T}O_6$–$(Ca)^{M2}(Al)^{M1}(AlSi)^{T}O_6$–$(\square)^{M2}(Si)^{M1}(Si_2)^{T}O_6$ with up to 2.25 atoms Si per formula unit have spectral features similar to jadeite. However, their distinct stability fields (if any) and synthesis pathways, considered together with textural constraints, have different implications for precursor phases and estimates of impactor size, encounter velocity, and crater diameter. A reassessment of reported jadeite occurrences casts a new light on many previous conclusions about the shock histories preserved in particular meteorites.

Keywords: High-pressure polymorphs, spectroscopy, planetary, pyroxenes, chondrites