

ちきゅう 船上のXCTデータによる超マフィック岩の構造解析

Structural analyses of ultramafic rocks used by X-ray CT core imaging (Oman Drilling Project Phase 2, D/V CHIKYU)

*道林 克禎¹、柿畑 優季¹、片山 郁夫²、岡本 敦³、岡崎 啓史⁴、Peter Kelemen⁵、高澤 栄一⁶
、Damon Teagle⁷、Oman Drilling Project Phase 2 Science Party⁸

*Katsuyoshi Michibayashi¹, Yuki Kakihata¹, Ikuo Katayama², Atsushi Okamoto³, Keishi Okazaki⁴,
Peter B Kelemen⁵, Eiichi TAKAZAWA⁶, Damon A H Teagle⁷, Oman Drilling Project Phase 2
Science Party⁸

1. 名古屋大学大学院環境学研究科、2. 広島大学、3. 東北大学、4. JAMSTEC 高知コアセンター、5. コロンビア大学、6. 新潟大学、7. サウサンプトン大学、8. ICDP

1. Department of Earth and Planetary Sciences, Graduate School of Environmental Studies, Nagoya University, 2. Hiroshima University, 3. Tohoku University, 4. KCC, JAMSTEC, 5. Columbia University of New York, 6. Niigata University, 7. Southampton University, 8. ICDP

X-ray computed tomography (X-ray CT) images were obtained on all cores drilled during Oman Drilling Project (OmanDP) Phase 2 (Holes CM1A, CM2B, BA1B, BA3A and BA4A) as a routine part of the IODP measurement protocol onboard D/V Chikyu. X-ray CT scanning enables the non-destructive observation of the internal structure of the core, providing information about chemical composition and density. The data are useful for assessing sample locations and quality. X-ray CT images can be used for 3D fabric analyses even after core has been cut in half and subsampled for other analyses.

The X-ray CT scanner (Discovery CT 750HD, GE Medical Systems) scans and reconstructs an image of a 1.4 m section in 10 minutes and produces a series of scan images, each 0.625 mm thick. The X-ray source and detector are installed inside of the gantry opposite each other. The excitation voltage and current for X-ray tube are 140kV and 100 mA, respectively.

Core samples are scanned in the gantry with a scanning rate of 20 mm/sec. The distribution of attenuation values mapped to an individual slice comprises the raw data that are used for subsequent image processing. Successive two-dimensional (2D) slices of 512 x 512 pixels yield a representation of attenuation values in three-dimensional (3D) voxels of 512 x 512 by ~1600 in length. Data generated for each core consist of core-axis-normal planes (XY planes) of X-ray attenuation values with dimensions of 512 x 512 pixels in 9 cm x 9 cm cross-section, with a resolution of 0.176 mm/pixel.

X-ray intensity varies as a function of X-ray path length and the linear attenuation coefficient (LAC) of the target material, which is a function of the chemical composition and density of the target material. The basic measure of attenuation, radiodensity, is the CT number given in Hounsfield units (HU). CT numbers of air and water are -1000 and 0, respectively.

CT numbers of OmanDP cores reveal structural features such as the attitude of foliation in primary peridotites, defined by spinel and orthopyroxene crystal shape. Combined with microstructural analyses such as EBSD mapping, we can study petrophysical properties of the uppermost mantle in the mantle section. Moreover, comparing with density profiles measured onboard, we can also estimate the degree of serpentinization in core from Holes BA1B, BA3A and BA4A, ranging from 80 to almost 100%. Profiles of the degree of serpentinization with depth may provide insight into ongoing serpentinization processes.

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