PRELIMINARY SULFUR ISOTOPE STUDIES ON CHELYABINSK CHONDRITE. T. Niihara[1], M. Koike[2], S. Kagoshima[2], K. Tanaka[2], Y. Sano[2] and H. Kaiden[3,4], [1]University Museum, University of Tokyo,(7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan. niihara@seed.um.u-tokyo.ac.jp), [2]Atmosphere and Ocean Research Institute, The University of Tokyo (5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8564, Japan) , [3]National Institute of Polar Research (10-3 Midori-cho, Tachikawa, Tokyo 190-8518, Japan), [4]SOKENDAI.

Introduction: Metal-sulfide (troilite) droplets are ubiquitous in impact-melted ordinary chondrites and other shocked extraterrestrial materials [e.g. 1-5]. Petrological and mineralogical signature of shocked meteorites are summarized by Stöffler et al [6] and Bennett et al. [7]. According to these papers, petrological signatures of troilite change with increasing degree of shock effect, and could be useful as shock-level indicator in addition to other silicate minerals. Metal-sulfide droplets are believed to be formed from eutectic melt [3]. Rubin [3] reported detailed petrological and metallic texture of Smyer H chondrite impact-melt breccia and found that troilite fills fractures of silicate minerals and FeS/Fe modal ratio is far different from eutectic weight ratio. From these observations, Rubin [3] suggested that troilite formed from low viscosity fluid (possibly sulfur vaporization during impact). If it is true, troilite could have isotopic anomaly by mass dependent fractionation.

Sulfur isotopic measurements of troilite in chondrules have been reported for several chondrite and have few isotopic anomalies [8, 9]. However, sulfur isotopes for impact melt rocks are not reported. Here we report sulfur isotope of troilite in shock melted lithology of Chelyabinsk chondrite.

Sample and method: Chelyabinsk chondrite fell in 2013 and iscomposed of light gray less shocked host and dark-highly shocked portions [10]. We used small droplets (~1 cm) composed of dark melted portion and relict materials (Fig. 1). We made a polished thin section and conducted optical microscope and scanning electron microscope observations. Mineral compositions are measured with EPMA. Sulfur isotopes are measured with Nano-SIMS at Atmosphere and Ocean Research Institute, University of Tokyo. Canyon Diablo Troilite is used as standard.

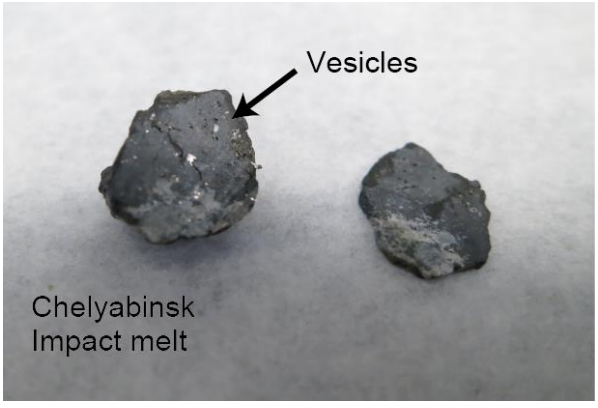

Figure 1. Impact melt portion of Chelyabinsk chondrite.

Results and discussion: Our Chelyabinsk chondrite composed of mostly shock melted and shock-darkened portion indicates it experienced a heavy shock event (Fig. 1). In the impact melt portion, an elongated shape chondrules is observed. Similar elongated shaped chondrules are commonly observed in chondritic impact melt rock as a result of mobilization of melt [4]. Impact melt portion contains abundant vesicles similar with other impact melted chondrite such as Cat Mountain and Gao-Guenie [2, 11]. These vesicles are thought to result from vaporization of volatiles such as sulfur during impact event (s) [1, 2].

Host chondritic portion shows darkening under optical microscope but petrological texture is not largely changed (silicate minerals are not melted). Chemical compositions of constitutent minerals are within range of LL chondrite. Irregular shaped troilite grains are observed in host chondritic portion. In addition to this, one chondrule is surrounded by troilite (left side of Fig. 2). Thin troilite veins occur at fractures in silicate minerals.

Impact melt has fine-grained rims in host contact regions that might result from rapid quenching. Relict

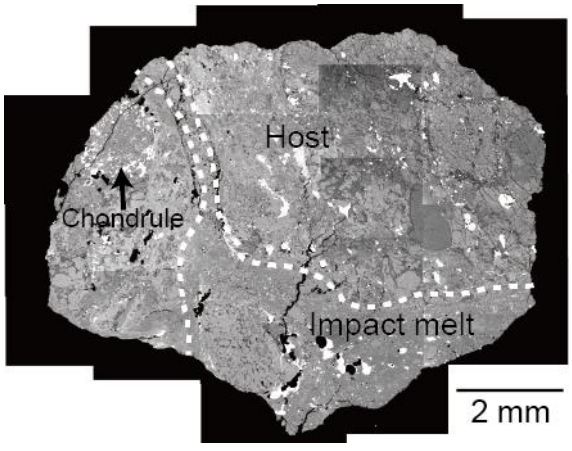

Figure 2. Mosaic map of Chelyabinsk chondrite used for sulfur isotopic measurement. Dashed line indicate melt-host boundary.

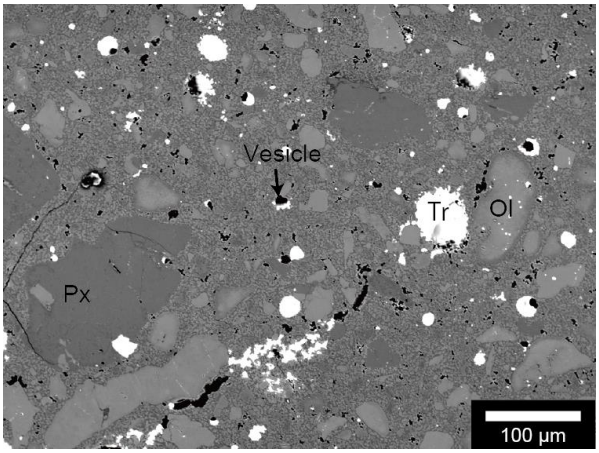

Figure 3. Impact melt portion of Chelyabinsk. Coarse grained relict materials are embedded in fine grained matrix. Some troilite droplets are adjacent with vesicles.

silicates (olivine and pyroxene; 20-200 μm) show rounded shapes embedded in fine grained matrix. In this region, several types of troilite grains occur. Most troilite grains occurs as droplets of troilite-metal dloplets with variety of sizes (1-500 μm). Some of the droplets are adjacent to vesicles (Fig.3). Other sulfide grains occurr along fractures in relict silicate minerals.

Sulfur isotope measurements are performed on both host and impact melt portions (Fig. 4). Irregular shaped troilite grains in host portion show almost uniform sulfur isotope compositions. On the other hand, troilite droplets in impact melt portion show wide range of negative anomalies. Troilite occuring at rim of chondrule in host shows unique signature. Troilite grains located near impact melt veins show negative anomaly up to -20 ‰ whereas far side troilite grains shows small sulfur isotope anomaly. Isotope anomaly could be indicative of sulfur vaporization during impact event on Chelyabinsk parental body.

Summary: We performed petrology, mineralogy and isotopic measurements on impact melted portion of Chelyabinsk chondrite. Significant sulfur isotope fractionation is observed probably evidence of vaporization of sulfur during impact event but further test is required.

References: [1]Miyamoto M. (1984) JGR 89, 11,581-11,588. [2]Kring D.A. et al. (1996) JGR 101, 29,353-29,371. [3]Rubin A. (2002) GCA 66, 699-711. [4]Niihara T. et al., (2011) Pol. Sci. 4, 558-573. [5]Rubin A. and Moore W.B. (2011) MAPS 46, 737-747. [6]Stöffler D. et al. (1991) GCA 55, 3845-3867. [7]Bennett M. E. III, and McSween H. Y. (1996) MAPS 31, 255-264. [8] Paterson B.A. et al. (1997) GCA 61, 601-609. [9]Tachibana S. and Huss G. R. (2005) GCA 69, 3075-3097. [10] Kohout T. et al. (2014) Icarus 228, 78-85. [11] Schmider M. (2016) MAPS 51, 1022-1045.

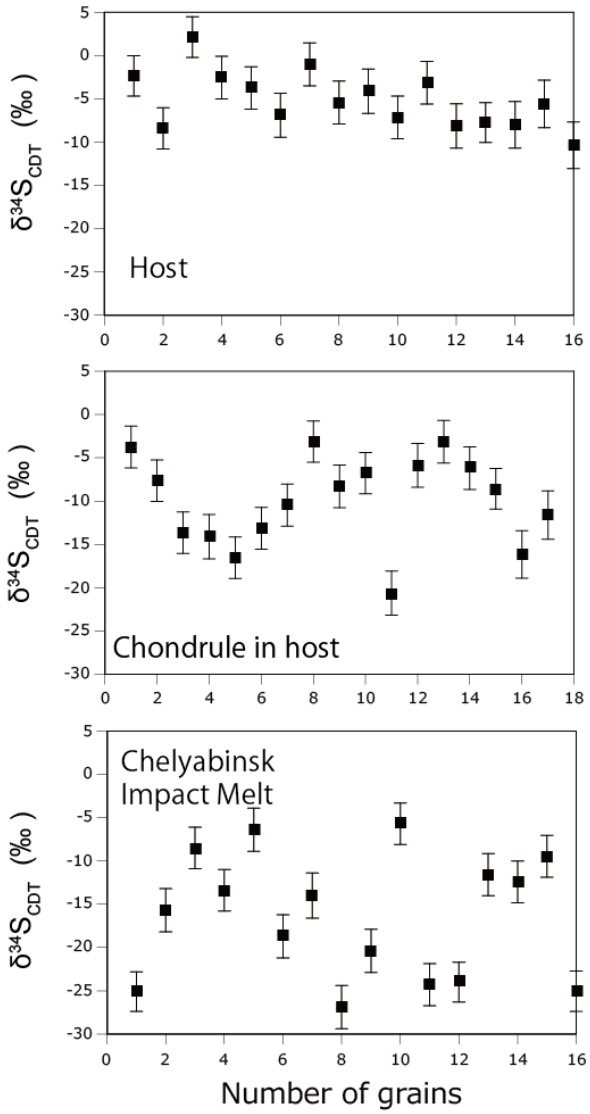

Figure 4. Sulfur isotope composition of troilite in Chelyabinsk chondrite. Troilite grains in host portion is almost uniform sulfur isotope compositions. Impact melt portion shows variety of sulfur isotope compositions with negative anomaly relative to host.

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