THE MINERALOGY AND GEOCHEMISTRY OF SHIDIAN: A NEW FALL OF CM CHONDRITE IN CHINA. Y. Fan1,2, S. J. Li1 and S. Liu2, 1Center for Lunar and Planetary Sciences, Institute of Geochemistry, Chinese Academy of Sciences,Guiyang 550081, China (fy535149891@outlook.com, ldlshijie@126.com), 2Department of Geology, Northwest University, Xi’an 710069, China (liushen@nwu.edu.cn).

Introduction: Carbonaceous chondrite (CC) meteorites are primitive fragments of asteroids, and CM chondrites are the largest group of hydrated meteorites [1,2]. Numerous CM chondrites have experienced aqueous alteration, which varies from less altered (i.e., CM2) to heavily altered (i.e., CM1) [2]. Additionally, secondary mineral such as phyllosilicate was formed during the aqueous alteration. Thus, based on the petrological, mineral and geochemical research on the carbonaceous chondrites, it may provide the information about the time and origin of solar nebula, formation and duration of chondrules and refractory inclusions, history of thermal metamorphism and aqueous alteration and etc. [3,4]. Based on the mineralogical and geochemical characteristics, we will provide the classification and alteration characteristics of Shidian, which is a new fall at Yunnan, China.

Samples and Methods: Shidian meteorite comprises two pieces both with fusion crust, and the interior of which is black with numerous white dots. Meteorites was sliced by diamond wire cutting machine (STX-603A), which was further processed as a polished thick section for analysis. Petrographic observations were carried out at Lunar and Planetary Science Research Center, Institute of Geochemistry, Chinese Academy of Sciences. Mineral compositions were determined by electron microprobe (JXA8230) at Guilin university of technology. Whole rock elemental concentration was determined at the State Key Laboratory of Environmental Geochemistry, Chinese Academy of Sciences. The bulk oxygen isotopic composition was measured at University of New Mexico. In addition, Chromium isotope composition was determined using a Thermo Triton Plus thermal ionization mass spectrometer at the University of California at Davis.

Results: Shidian meteorite mainly consist of chondrules (15.4 vol%; 0.38±0.12mm, n=11), fine-grained matrix (84.6 vol%) (Fig. 1). The chondrules of Shidian are type-I chondrule, in which fractured forsterite (Fo=99.49±0.16, n=11) can be observed. The matrix mainly comprise phyllosilicate, isolated forsterite, troilite, calcite and magnetite. The FeO/SiO2 of poorly characterized phase (PCP) was measured as 0.58±0.14, n=4. In addition, Shidian has the characteristic oxygen isotopic compositions with δ17O ranging from -1.32 to 0.14, δ18O ranging from 5.45 to 6.33 and Δ17O ranging from -3.238 to -3.614. The Cr isotope compositions are characterized by ε54Cr=1.00±0.11 and ε53Cr=0.20±0.06.

Discussions: Shidian has abundant matrix (84.6%) (Fig. 1), similar to most CM chondrites [5]. Chemical analysis shows that Shidian is depleted highly volatile element, and has flat rare earth elements pattern, which resembles to Paris CM chondrite [6] (Fig. 2). Additionally, the oxygen isotope compositions of Shidian is below the terrestrial fractionation line in oxygen three-isotope plot, and located in the CM chondrite field (Fig. 3). Chromium isotopes combined oxygen isotopes as in [7,8] shows that Shidian has the consistent ε54Cr with typical CM chondrites (Fig. 4). Therefore, we suggested that Shidian should be classified as CM chondrite. Additionally, Shidian has experienced aqueous alteration as revealed by the abundant phyllosilicate in fine-grained matrix and fine-grained rims (Fig. 1), but residual fractured chondrules still can be recognized, which suggests that Shidian should be CM2 chondrite [9].

Sequences of CM chondrites aqueous alteration have been reported [10,11]. It is suggested that Fe-rich component in CM chondrites are more easily altered than Fe-poor component [10]. Besides, it is also suggested that during the early and intermediate alteration stage, fine-grained matrix was hydrated, PCP formed and primary igneous glass was altered [11]; With the progressive alteration, metallic Fe-Ni was oxidized, the chondrule phenocrysts was altered and the compositions of PCP was changed [11]. There are abundant fructures in the chondrule phenocrysts of Shidian, in which phyllosilicate is developed. In addition, Fe-rich olivine and pyroxene may be altered totally, which could be further verified in the Fe element mapping (Fig. 1). Therefore, these characteristics implies that Shidian has experienced severe aqueous alteration. Besides, most metal Fe-Ni in Shidian has been oxidized, and the abundance of remaining Fe-Ni metal is about 0.2%. Nearly 60% chondrule phenocrysts have been altered (Fig. 1). Furthermore, combining the low FeO/SiO2 (<2.0) of PCP, we suggested that Shidian should be CM2.2 subtype [11].

Conclusions: 1. Based on petrological characteristics, in situ olivine chemistry analysis, bulk major and trace elements analysis, bulk oxygen and chromium isotopic analyses, Shidian meteorite is classified as CM2 chondrites. 2. Shidian has experienced serious
aqueous alteration, suggesting it should be CM2.2 subtype based on the mineralogical and textural properties.

Fig. 1 Backscattered electron (BSE) and energy dispersive spectrometer (EDS) mapping for Shidian (CM 2.2).

Fig. 2 Analysis of (a) rare earth element (REE) and (b) other elements ordered in volatility sequence for Shidian (CM2.2) and other chondrites. Data of Shidian is from this study, data of Paris is from [6], data of Sutter’s Mill is from [12], data of CI chondrites is from [13], and data of other chondrites are from [14].

Fig. 3 Oxygen three-isotope plot for bulk Shidian, Paris and other chondrites. Data of Shidian is from this study, data of Paris is from [6], and data of other chondrites are from [15,16].

Fig. 4 $\Delta^{17}O - \varepsilon^{54}Cr$ composition of Shidian. The figure was modified from [17]. Data of Diepenveen is from [18]. Data of other meteorites are from [17] and references therein.