HYDROGEN ISOTOPES OF PHOSPHATES IN THE NEW MARTIAN METEORITE GRV 99027. Y. Guan[1], Weibiao Hsu[2], L. A. Leshin[1,3], Henian Wang[4], Rucheng Wang[4], Fusheng Zhang[5], Chengyi Lin[5], and Wenlan Zhang[4], [1]Department of Geological Sciences, Arizona State University, Tempe AZ 85287-1404, USA (yunbin.guan@asu.edu). [2]Purple Mountain Observatory, Nanjing 210008, China. [3]Center for Meteorite Studies, Arizona State University, USA. [4]Department of Earth Sciences and Laboratory of Mineralizing Process of Ore Deposits; [5]Center for Material Analysis, Nanjing University, Nanjing 210093, China.

Introduction: Based on its petrography and mineralogy, the Antarctic meteorite Grove Mountains (GRV) 99027 has been classified as the fourth known lherzolitic shergottite, after ALH 77005, Yamato 793605 and LEW 88516 [1, 2]. It consists mainly of olivine (Fa_{24-31}), low- ($En_{61-76}Fs_{21-27}Wo_{3-14}$) and high- ($En_{48-52}Fs_{13-16}Wo_{33-38}$) Ca pyroxenes, and plagioclase ($An_{49-55}Or_{<1}$), with minor amounts of phosphates, chromite, and ilmenite. In this study, we have determined the hydrogen isotopic compositions of phosphates found in this new meteorite.

Experimental Techniques: Phosphate phases were systematically searched for and identified in one GRV 99027 polished thin section using a JEOL-845 scanning electron microscope (SEM) equipped with an IXRF energy-dispersive (EDS) detector system. Hydrogen isotopes and water concentrations in found phosphates were measured using the Cameca ims-6f ion microprobe at Arizona State University. Due to the extensive occurrence of small cracks in the phosphate grains, a small (~5 μm) 10 KeV Cs primary beam had to be used to avoid contamination from surrounding epoxy material. In order to increase transmission, secondary ion signals were collected at -9 KeV with an ion image field of 75 μm. Sample charging was compensated by a normal incidence electron-flooding gun. Instrumental mass fractionation and hydrogen background corrections were made using terrestrial apatite standards and olivine in the GRV 99027 thin section. Water contents in spots analyzed for D/H were also determined using terrestrial apatite standards, selecting ^{31}P as the reference mass. The uncertainties of water concentration analyses are between ~5-18% relative.

Results and Discussion: The phosphate grains found in the GRV 99027 thin section occur interstitially among olivine, pyroxene, and plagioclase grains (see Fig. 1). Their sizes range from less than 10 μm to about 150 μm. Many of the phosphate grains are crosscut by plagioclase (maskelynite) veins. Based on their EDS spectra, most of the phosphate grains can be identified as whitlockite. Small amounts of apatite can be found inside a few of the whitlockite grains.

Six of the phosphate grains were analyzed for their D/H ratios and water concentrations. The analysis yielded δD values from +1300 to +4700‰, water contents from 0.05 to 0.43 wt. % (Table 1). No correlation exists between D/H ratios and water contents in these GRV 99027 phosphate grains. SEM examination after ion microprobe measurement showed that the mineral phases sampled in each spot are either whitlockite or apatite, or the mixture of both. The presence of apatite grains obviously contributes to the high water contents in some of the spots.

Previous studies have established that water highly enriched in deuterium is an unique feature of apatite in martian meteorites [3-5]. This enrichment has been interpreted as the result of isotopic exchange between igneous apatite and martian crustal fluids with near martian atmospheric D/H values (~5.2 times terrestrial), though shock remains a possible alternative explanation. The high D/H ratios observed in GRV 99027 phosphates indicate that they have hydrogen isotopic compositions similar to apatite found in other martian meteorites.

In addition, like the apatite in Zagami, Los Angeles, and QUE 94201 [3-5], the phosphate grains in GRV 99027 display large variations in their D/H ratios (Table 1). Water contents are also variable, as was observed in QUE 94201 apatite [4]. Relative to the QUE 94201 data, however, the phosphate grains in GRV 99027 contain much less water, obviously because many of the analyzed spots in this study sampled whitlockite, instead apatite. Also, D/H ratios and water content of GRV 99027 phosphate grains do not display a clear correlation as manifested by the QUE

94201 apatite data [4]. Because the analyzed phosphate grains in this study represent both apatite and whitlockite, one possibility is that these two minerals may have distinct trends in D/H-water content space.

In spite of the complication discussed above the phosphate minerals from QUE 94201, Zagami, Los Angles, and GRV 99027 have similar D/H ranges. Although small variability could be introduced during ion probe measurement, such large D/H variations most reasonably represent an intrinsic heterogeneity of hydrogen isotopic distributions in martian meteorites. The variation is hypothesized to result from incomplete exchange of hydrogen isotopes between phosphate minerals containing magmatic hydrogen and crustal fluids with near martian atmospheric D/H values [3, 4].

Conclusions: Water in GRV 99027 phosphate grains yields high and variable D/H ratios, consistent with previous analyses of apatite in other martian meteorites. The results from this study have further confirmed the association of GRV 99027 with the martian meteorite group.

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References: [1] Lin C. et al. (2002) *LPS XXXIII,* Abstract #1562. [2] Lin Y. et al. (2002) *Meteoritics & Plant. Sci,* 37, A87. [3] Waston L. L. et al. (1994) *Science* 265, 86-90. [4] Leshin L. A. (2000) *GRL* 27, 2017-2020. [5] Rubin A. E. et al. (2000) *Geology* 28, 1011-1014.

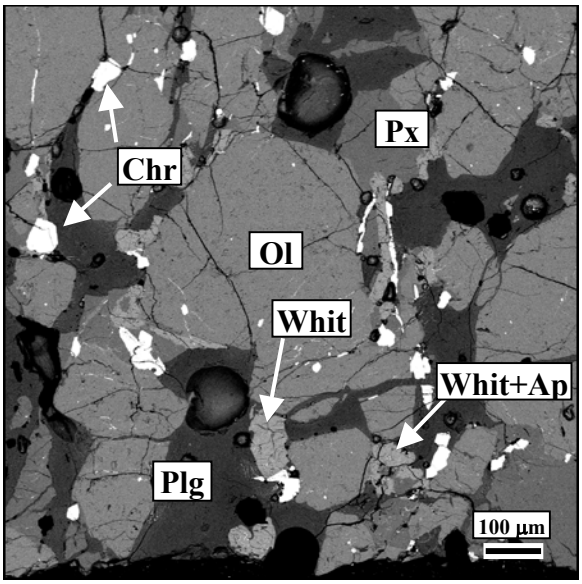

Fig. 1 Phosphate grains in GRV 99027

Table 1 D/H and water contents of GRV 99027 phosphates

Sample	Phases Analyzed	δD (‰)± 2σ	H_2O (wt.%)
Grain 1	Whit	4745± 309	0.05
Grain 2, a	Whit	2179± 246	0.11
Grain 2, b	Whit	2153± 251	0.09
Grain 3	Whit	2387± 271	0.07
Grain 4	Whit + Ap	1326± 193	0.12
Grain 5	Whit + Ap	1902± 167	0.24
Grain 6	Ap	4064± 283	0.43

a, b - different spots in a single grain

Abbreviations used in Fig. 1 and Table 1: Whit – whitlockite, Ap – apatite, Ol – olivine, Px – pyroxene, Plg – plagioclase, Chr – chromite.