COMPARATIVE PETROLOGY AND GEOCHEMISTRY OF THE LAPAZ MARE BASALT METEORITES. James M.D. Day[1], Lawrence A. Taylor[1], Allan D. Patchen[1], Darren W. Schnare[1], and D. Graham Pearson[2], [1]Planetary Geosciences Institute, University of Tennessee, Knoxville, TN 37996, USA (jday13@utk.edu) [2]Department of Earth Sciences, University of Durham, DH1 3LE, UK.

Introduction: Low-Ti lunar mare basalt meteorites LAP 02-205, -224, -226, -436, and LAP 03-632 were discovered in the LaPaz icefield, Antarctica during the 2002/2003 ANSMET field season [1,2]. Oxygen isotope compositions of LAP 02-205 [1], along with mineralogy, mineral compositions, and strong negative whole-rock Eu anomalies in all of the basalts, confirm the lunar origins of these meteorites. Here we present a detailed petrological and geochemical study of these basalts demonstrating that they are paired as expected [1,2]. The LaPaz basalts are evolved with abundant mesostasis areas (up to 3%), elevated rare earth element abundances, and extreme Fe enrichment, all the way to pyroxferroite. These basalts represent a significant new suite of evolved lunar lavas with which to compare with Apollo mare basalts, and on which to perform detailed geochemical studies [e.g., 3,4]. The basalt compositions best approximate to Apollo 12 ilmnenite or pigeonite mare basalts, perhaps indicating an origin in the region of Mare Procellarum.

Analytical Methods: Eight sections of the LAP meteorites (LAP 02-205,36 & 42; -224,26 & 28; -226,19 & 20; -436,18, and 03-632,6) were studied using a petrographic microscope. Mineral compositions were measured using a Cameca SX50 electron microprobe and mineral modes were determined on Feature Scan software with an Oxford instrument Energy Dispersive Unit using the procedure of Taylor *et al.* [5]. Trace element concentrations were measured on 20mg aliquots, from a 1.5-2g powder, using an ELAN 6000 ICP-MS following the procedure of Ottley *et al.* [6].

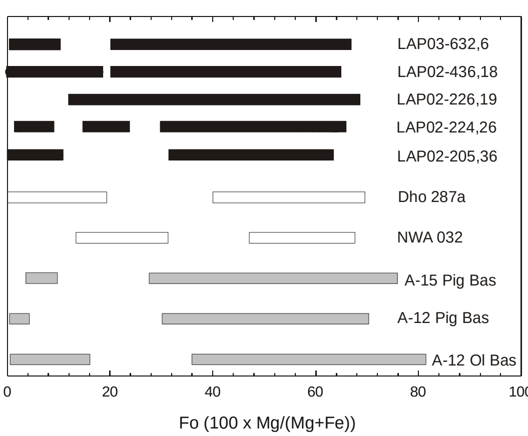

Fig. 1 – Composition of LaPaz olivines. Data for Dho287a, NWA032, and Apollo 12 and 15 quoted in [7].

Results and Discussion: *Texture and mineralogy.* The LaPaz meteorites are holocrystalline basalts containing

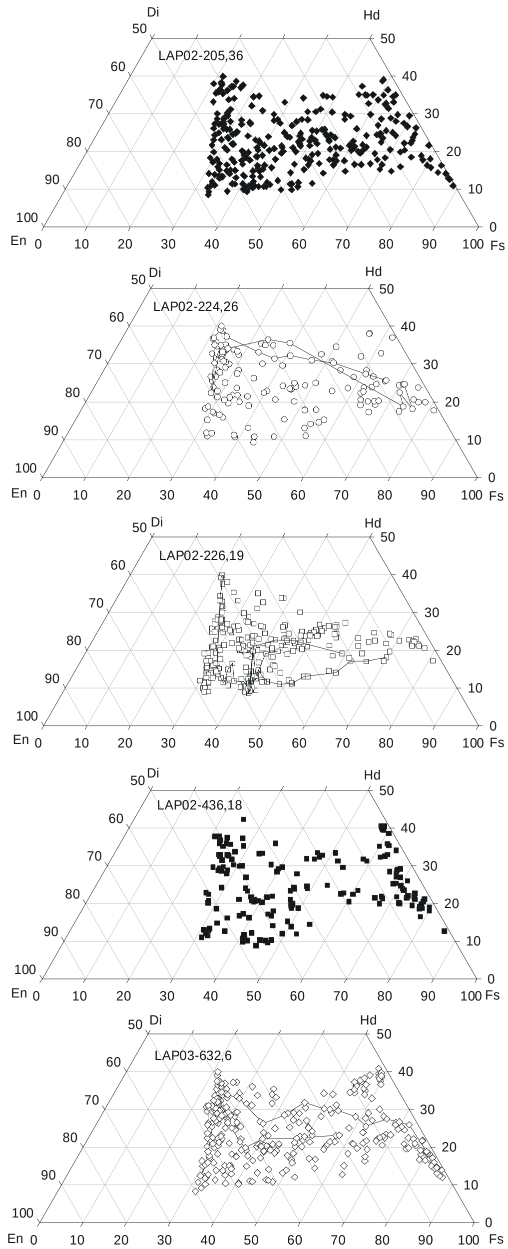

Fig. 2 – Ca-Fe-Mg variations in LaPaz pyroxenes

similar proportions of augite, plagioclase (An_{79-93}), pigeonite, ilmenite, troilite, and free silica, in addition to more variable quantities of K-rich glass, ulvöspinel, chromite, phosphates, FeNi metals, baddelyite, fosteritic (Fo_{20-67}), and fayalitic olivine ($<Fo_{20}$) (Table

1). A significant feature of all the basalts is the abundance of mesostasis and free silica, as well as the evidence for shock including mosaic fracture and planar deformation of pyroxene and olivine, partial maskelynitisation of plagioclase, and the presence of shock-induced glass melt veins.

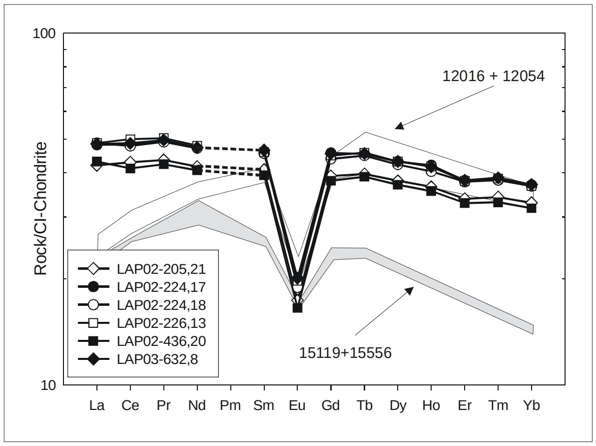

Fig 3. – Chondrite normalized trace element plot of LaPaz mare basalts. Data for Apollo basalts is from Fagan et al. [7].

Mineral compositions: Mineral compositions and compositional evolution are near identical for the LaPaz basalts. For example, the basalts have common ranges in olivine (Fig. 1), plagioclase, and spinel compositions, comparable and unusually high abundances of Co and Ni in FeNi metals [4], and near-identical pyroxene variations to extreme Fe-enriched rims (Fig. 2). Figs. 1 and 2 serve to demonstrate the similarity of the LaPaz basalts to low-Ti Apollo 12 and 15 mare basalts, as well as low-Ti basalt meteorite NWA 032.

Whole rock chemistry. The *Mg#* of the LaPaz meteorites (*Mg#* = 30-36) are similar to some low-Ti A12 and A15 quartz normative or pigeonite normative basalts, consistent with the evolved nature of these basalts. However, at the same value of *Mg#*, the LaPaz basalts are more enriched in rare earth elements (REE) than evolved low-Ti Apollo basalts, especially in terms of their light-REE inventories (e.g., Fig.3). This light -REE enrichment maybe from the 'KREEP' signature of the mesostasis in the form of phosphate minerals such as Cl-F-rich apatite, or less commonly, merrillite.

Suggested lunar source regions: Although more evolved, the LaPaz mare basalts are similar to low-Ti Apollo mare basalts. In terms of mineral chemistry, the LaPaz basalts are most similar to Apollo 12 basalts, especially the ilmenite or pigeonite basalts [8]. The high Co and Ni concentrations in some FeNi metals [4] also suggest a source region similar to that of the A12 basalts. The high REE contents, relatively young age (2.9Ga [8]), and the unique metals in the LaPaz basalts allow us to tentatively propose a source origin in the Mare Procellarum terrain of the western near-side of the Moon.

[1] Ansmet Newsletter (2003), 26 (2). [2] Ansmet Newsletter (2004), 27 (1,3). [3] Day J.M.D. *et al.* (2005) *LPSXXXVI,* this volume. [4] Taylor L.A. and Day J.M.D, (2005), *LPS XXXVI*, this volume. [5] Taylor L.A. *et al.* (1996), *Icarus*, 124, 500-512. [6] Ottley C.J. *et al.* (2003) In: Holland J.G and Tanner S.D. (eds.) *Plasma Source Mass Spectrometry, Applications and Emerging Technologies.* Royal. Soc. Chem. Spec. Pub, 221-230. [7] Anand M.A. *et al.* (2004), *LPS XXXV*, 1626. [8] Fagan T.J. *et al.* (2002) *MaPS*, 37, 371-394.

Table 1: Modal analysis of the LaPaz mare basalt meteorites (as percentages)

	LAP02-205	LAP02-224o	LAP02-224i	LAP02-226	LAP02-436	LAP03-632	Average	StDev	RSD%
Fayalite	1.41	1.52	2.20	1.59	2.01	1.90	1.77	0.31	17.5
SiO2	2.34	1.86	2.18	2.34	2.02	1.91	2.11	0.21	10.0
K-Gls	0.66	0.66	0.79	0.60	0.80	0.69	0.70	0.08	11.4
Melt	1.48	2.15	1.26	1.85	2.08	1.25	1.68	0.40	24.1
FeS	0.20	0.22	0.21	0.20	0.19	0.24	0.21	0.02	9.0
Ilm	3.30	3.00	3.70	3.53	3.27	3.46	3.38	0.24	7.1
Usp	0.42	0.47	0.33	0.39	0.38	0.32	0.38	0.06	14.6
Chrom	0.06	0.16	0.16	0.08	0.10	0.17	0.12	0.05	37.7
Phos	0.27	0.20	0.26	0.24	0.20	0.24	0.24	0.03	12.9
Fe Met	0.00	0.00	0.00	0.00	0.00	0.00	-	-	-
Cpx	43.73	43.59	41.31	44.10	42.86	42.39	**43.00**	**1.03**	**2.4**
Pigeon	11.43	12.11	11.14	11.71	11.71	12.42	**11.75**	**0.46**	**3.9**
Oliv	1.18	1.90	3.13	1.26	1.62	1.90	1.83	0.71	38.6
Plag	33.52	32.16	33.35	32.10	32.77	32.84	**32.79**	**0.59**	**1.8**