14073

KREEP Basalt

10.35 grams

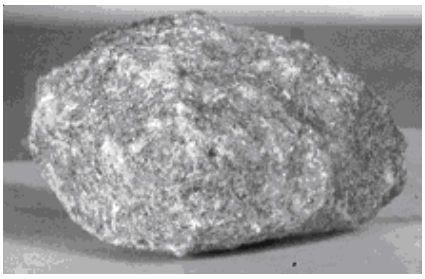
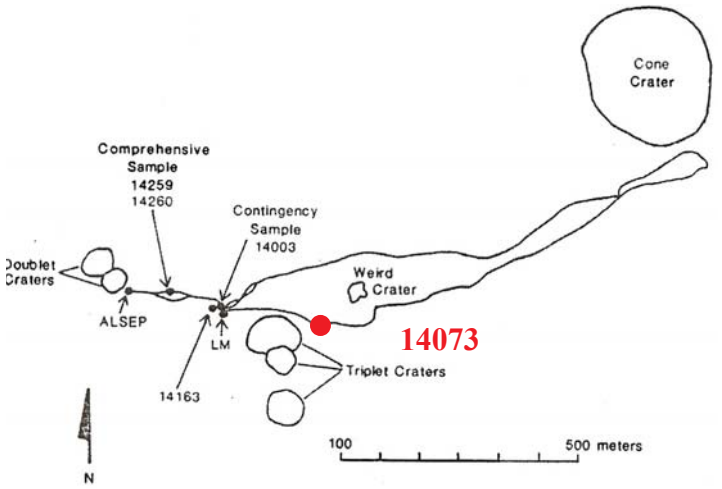


Figure 1: Photo of 14073. Sample is 3 cm across. NASA S71-26078.



Introduction

14073 is from the bottom of the trench at station G (see section on 14149). It is a KREEP basalt very like 14310 (Meyer 1977). It crystallized 3.88 b.y. ago and has been exposed to cosmic rays for 113 m.y.

Petrography

Gancarz et al. (1971) describe 14073 as a subophitic, intergranular to intersertal, orthopyroxene basalt with KREEP "affinity". It is composed of 50% plagioclase, 25% clinopyroxene, 20% orthopyroxene with minor ilmenite (2%), troilite, Fe-metal, phosphates(2), Fe-Ti-Zr silicates and mesostasis (figure 3 a,b).

14073 may be a clast-free impact melt rock like 14310.

Chemistry

Laul et al. (1972) reported the chemical composition (figure 6), but did not determine the siderophiles. It is similar to the composition of 14310 (table 1) and somewhat low in REE compared with KREEP (McKay et al. 1979).

Radiogenic age dating

Papanastassiou and Wasserburg (1971) determined a Rb/Sr isochron (whole rock, plagioclase and quintessence only) 3.88 ± 0.04 b.y. with I = 0.70034. Turner et al. (1972) used the Ar/Ar plateau technique and determined that plagioclase gave the best result (also 3.88 ± 0.05 b.y.).

If 14073 (and 14310) are impact melt rocks, then they might give the best age for the Imbrium impact event.

Cosmogenic isotopes and exposure ages

Turner et al. (1972) calculate an Ar exposure age of 113 m.y., which requires that the sample be at or near the lunar surface for that long or longer. It was found buried about 20 cm, and the age of Cone Crater is younger (Arvidson et al. 1975).

Other Studies

Morrison et al. (1972) reported a "moderate" number of zap pits on 14073.

Burnett et al. (1972) determined the density of solar flare tracks.

Processing

Samples 14073 – 14079 were returned in bag 20N, included in ALSRC 1006. There are 6 thin sections for 14073. Gerry Wasserburg is listed as consortium chief for 14073.

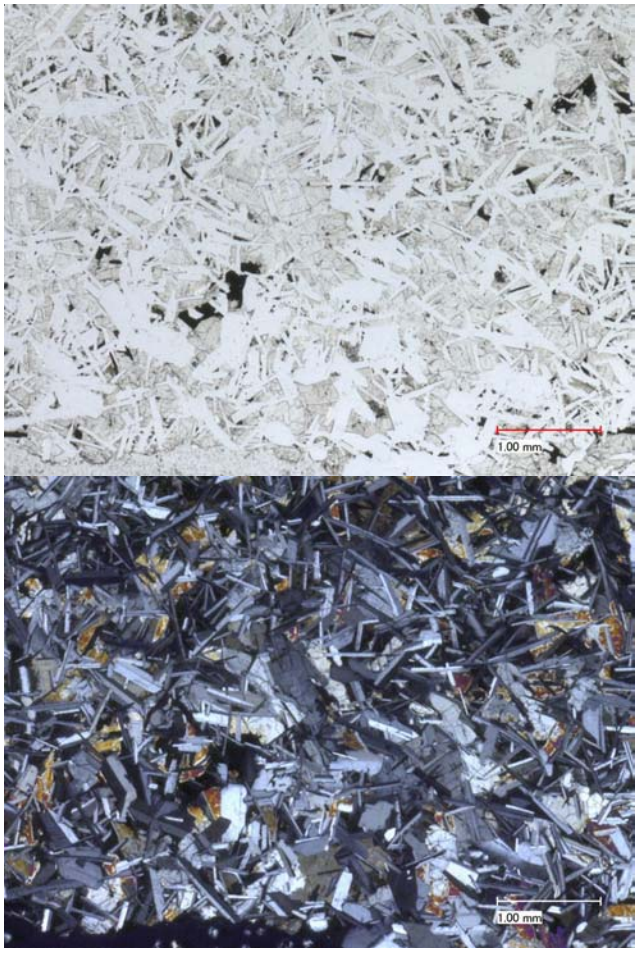


Figure 3a: Photomicrograohs of 14073,10 by C Meyer @ 50 x.

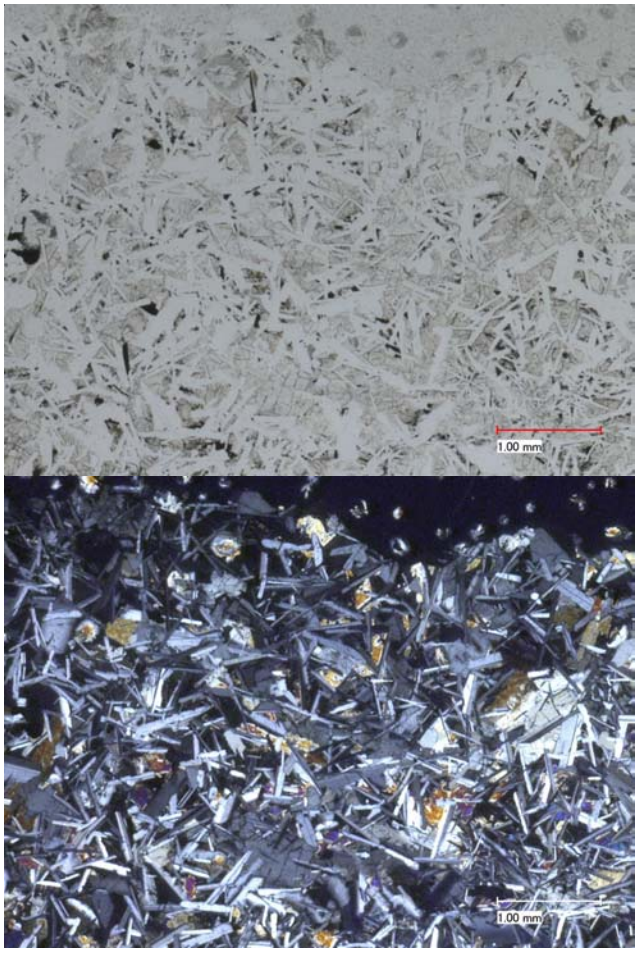


Figure 3b: Photomicrograohs of 14073,11 by C Meyer @ 50 x.

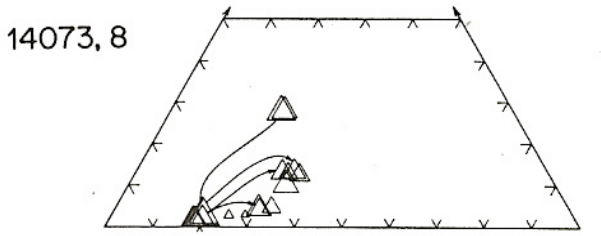


Figure 4: Composition of pyroxene in 14073 (Gancarz et al. 1971).

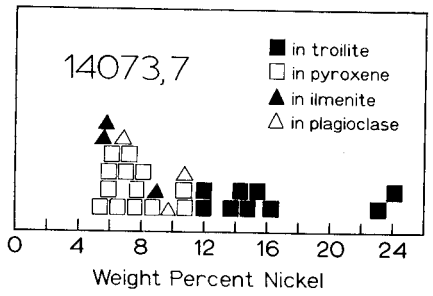


Figure 5: Composition of metallic iron in 14073 (ElGoresy et al. 1972).

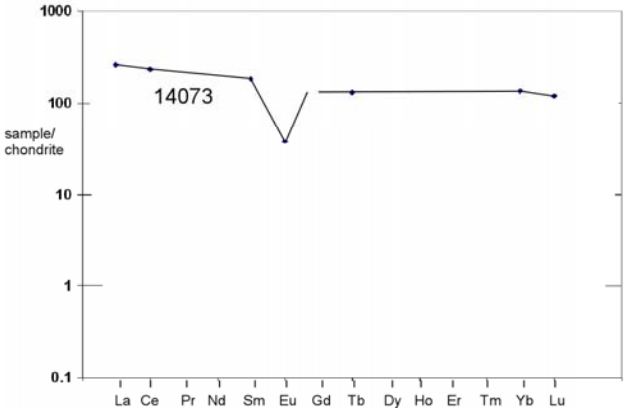


Figure 6: Normalized rare-earth-element diagram for 14073 (Laul et al. 1972).

Table 1. Chemical composition of 14073.

							14310	
reference	Laul72			Tera72			Philpotts 72	
weight	powder	frag.						
SiO2 %							48.3	(c)
TiO2	1.2	1.3	(a)				1.25	(c)
Al2O3	20	20.8	(a)				20.74	(c)
FeO	8.9	8.2	(a)				7.78	(c)
MnO	0.12	0.108	(a)				0.11	(c)
MgO							8	(c)
CaO	13	12.8	(a)				11.61	(c)
Na2O	0.76	0.737	(a)				0.76	(c)
K2O	0.48	0.49	(a)				0.52	(c)
P2O5							0.38	(c)
S %								
sum								
Sc ppm	21	18.7	(a)					
V	45	29	(a)					
Cr	1341	1026	(a)				1163	(b)
Co	18	18	(a)					
Ni								
Cu								
Zn								
Ga								
Ge ppb								
As								
Se								
Rb							12.7	(b)
Sr							180.9	(b)
Y								
Zr	810	660	(a)				893	(b)
Nb								
Mo								
Ru								
Rh								
Pd ppb								
Ag ppb								
Cd ppb								
In ppb								
Sn ppb								
Sb ppb								
Te ppb								
Cs ppm								
Ba	660	600	(a)				649	(b)
La	60	61	(a)					
Ce	196	142	(a)				143	(b)
Pr								
Nd							87.9	(b)
Sm	26.4	27	(a)				24.6	(b)
Eu	2.2	2.1	(a)				2.09	(b)
Gd								
Tb		4.8	(a)					
Dy							31.7	(b)
Ho								
Er							19.3	(b)
Tm								
Yb	21	22	(a)				18.1	(b)
Lu	2.9	2.9	(a)				2.66	(b)
Hf	17	21	(a)				21	(b)
Ta		2.4	(a)					
W ppb								
Re ppb								
Os ppb								
Ir ppb								
Pt ppb								
Au ppb								
Th ppm	8	11	(a)	11.8	(b)			
U ppm		2.6	(a)	3.22	(b)			

technique: (a) INAA, (b) IDMS, (c) AA

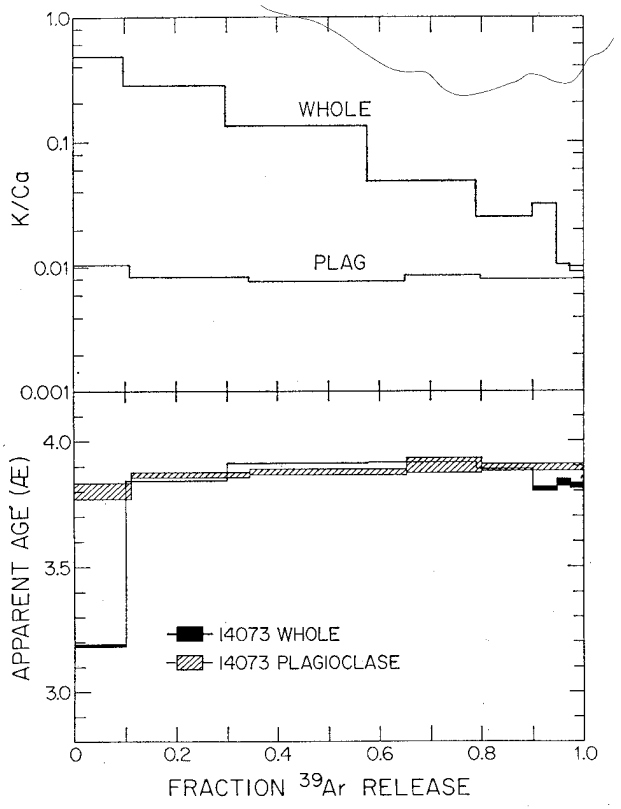
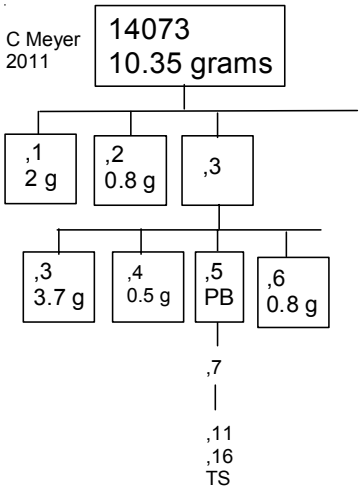


Figure 7: Ar plateau diagram for 14073 (Turner 1972).

Summary of Age Data for 14073

	Ar/Ar	Rb/Sr
Papanastassiou 1971		3.88 ± 0.04 b.y.
Turner et al. 1972	3.88 ± 0.05	

Caution: Beware of decay constants



References for 14073

Arvidson R., Crozaz G., Drozd R.J., Hohenberg C.M. and Morgan C.J. (1975) Cosmic ray exposure ages of features and events at the Apollo landing sites. *The Moon* **13**, 259-276.

Brown G.M., Emeleus C.H., Holland G.J., Peckett A. and Phillips R. (1972) Mineral-chemical variations in Apollo 14 and Apollo 15 basalts and granitic fractions. *Proc. 3rd Lunar Sci. Conf.* 141-157.

Burnett et al. (1972) The irradiation history of lunar samples (abs). *Lunar Sci.* **III**, 105-107.

Carlson I.C. and Walton W.J.A. (1978) **Apollo 14 Rock Samples**. Curators Office. JSC 14240

Clayton R.N., Hurd Julie and Mayeda Toshiko K. (1972) Oxygen isotopic compositions and oxygen concentrations of Apollo 14 and Apollo 15 rocks and soils. *Proc. 3rd Lunar Sci. Conf.* 1455-1463.

El Goresy A., Taylor L.A. and Ramdohr P. (1972) Fra Mauro crystalline rocks: Mineralogy, geochemistry and subsolidus reduction of the opaque minerals. *Proc. 3rd Lunar Sci. Conf.* 333-349.

von Engelhardt W. (1979) Ilmenite in the crystallization sequence of lunar rocks. *Proc. 10th Lunar Sci. Conf.* 677-694.

Gancarz A.J., Albee A.L. and Chodos A.A. (1971) Petrologic and mineralogic investigation of some crystalline rocks returned by Apollo 14 mission. *Earth Planet. Sci. Lett.* 12, 1-18.

Hubbard N.J., Gast P.W., Rhodes J.M., Bansal B.M., Wiesmann H. and Church S.E. (1972) Nonmare basalts: Part II. *Proc. 3rd Lunar Sci. Conf.* 1161-1179.

Laul J.C., Wakita H., Showalter D.L., Boynton W.V. and Schmitt R.A. (1972) Bulk, rare earth, and other trace elements in Apollo 14 and 15 and Luna 16 samples. *Proc. 3rd Lunar Sci. Conf.* 1181-1200.

LSPET (1971) Preliminary examination of lunar samples from Apollo 14. *Science* **173,** 681-693.

McKay G.A., Wiesmann H., Bansal B.M. and Shih C.-Y. (1979a) Petrology, chemistry, and chronology of Apollo 14 KREEP basalts. *Proc. 10th Lunar Planet. Sci. Conf.* 181-205.

Meyer C. (1977) Petrology, mineralogy and chemistry of KREEP basalt. *Physics and Chemistry of the Earth* **10**, 239-260. (Ahrens and Runcorn , eds)

Morrison D.A., McKay D.S., Heiken G.H. and Moore H.J. (1972) Microcraters on lunar rocks. *Proc. 3rd Lunar Sci. Conf.* 2767-2791.

Papanastassiou D.A. and Wasserburg G.J. (1971) Rb-Sr ages of igneous rocks from the Apollo 14 mission and the age of the Fra Mauro Formation. *Earth Planet. Sci. Lett.* 12, 36-48.

Papike J.J., Hodges F.N., Bence A.E., Cameron M. and Rhodes J.M. (1976) Mare basalts: Crystal chemistry, mineralogy and petrology. *Rev. Geophys. Space Phys*. 14, 475-540.

Reimold W.U., Nyquist L.E., Bansal B.M., Wooden J.L., Shih C.-Y., Wiesmann H. and Mackinnnon I.D.R. (1985) Isotope analysis of crystalline impact-melt rocks from Apollo 16 stations 11 and 13. North Ray Crater. *Proc. 15th Lunar Planet. Sci. Conf.* in J. Geophys. Res. 90, C597-C612.

Simonds C.H., Phinney W.C., Warner J.L., McGee P.E., Geeslin J., Brown R.W. and Rhodes J.M. (1977) Apollo 14 revisited, or breccias aren't so bad after all. *Proc. 8th Lunar Sci. Conf.* 1869-1893.

Sutton R.L., Hait M.H. and Swann G.A. (1972) Geology of the Apollo 14 landing site. *Proc. 3rd Lunar Sci. Conf.* 27-38.

Swann G.A., Trask N.J., Hait M.H. and Sutton R.L. (1971a) Geologic setting of the Apollo 14 samples. *Science* **173**, 716-719.

Swann G.A., Bailey N.G., Batson R.M., Eggleton R.E., Hait M.H., Holt H.E., Larson K.B., Reed V.S., Schaber G.G., Sutton R.L., Trask N.J., Ulrich G.E. and Wilshire H.G. (1977) Geology of the Apollo 14 landing site in the Fra Mauro Highlands. U.S.G.S. Prof. Paper 880.

Swann G.A., Bailey N.G., Batson R.M., Eggleton R.E.., Hait M.H., Holt H.E., Larson K.B., McEwen M.C., Mitchell E.D., Schaber G.G., Schafer J.P., Shepard A.B., Sutton R.L., Trask N.J., Ulrich G.E., Wilshire H.G. and Wolfe E.W. (1972) 3. Preliminary Geologic Investigation of the Apollo 14 landing site. *In* Apollo 14 Preliminary Science Rpt. NASA SP-272. pages 39-85.

Turner G., Huneke J.C., Podosek F.A. and Wasserburg G.J. (1971) 40Ar-39Ar ages and cosmic ray exposure ages of Apollo 14 samples. *Earth Planet. Sci. Lett.* **12**, 19-35.

Turner G., Huneke J.C., Podosek F.A. and Wasserburg G.J. (1972) Ar40-39 systematics in rocks and separated minerals from Apollo 14. *Proc. 3rd Lunar Sci. Conf.* 1589-1612.