

ELASTIC WAVE VELOCITIES AND THERMAL DIFFUSIVITIES OF APOLLO 17 ROCKS, Hitoshi Mizutani and Masahiro Osako, Geophysical Institute, University of Tokyo, Tokyo, Japan.

This paper presents new experimental results of elastic-wave velocities and thermal diffusivities of Apollo 16 and 17 rocks. The compressional- and shear-wave velocities of one Apollo 16 rock, 61175,22 and four Apollo 17 rocks, 70215,30; 73235,18; 74275,25; and 77017,24 were measured at pressures up to 10 kb. The thermal diffusivities were measured for sample 70215,30 and 77017,24 as a function of ambient gas pressure from 1 bar to 10^{-6} torr.

Elastic-wave velocities were measured with the pulse-transmission method using 10 Mhz PZT transducers. The thermal diffusivities were measured with the Angstrom method (1).

Both samples 61175 and 77017 were light gray anorthositic gabbro of very low coherence. Sample 70215 is a fine-grained basalt. Sample 73235 is a meta-breccia containing large white lithic clasts. Sample 74275 is a porphyritic basalt.

The experimental results of the elastic-wave velocities are summarized in Table 1. Like the results of Apollo 11 to 16 rocks, the velocities increase rapidly with pressure for the initial few kilobars. The compressional- and shear-wave velocities of sample 70215, 73235, and 74275 give very similar velocity-pressure curves to each other's. The velocity data of these are almost same as those of crystalline lunar basalts from previous Apollo missions and considered to be typical of the seismic velocities in the lunar crust. The elastic-wave velocities of the anorthositic rocks (61175,22 and 77017,24) studied in the present work are very low in the lunar crust condition. The low velocities of the anorthositic rocks are due to low cohesion of these rocks; high pressure only does not improve the mechanical cohesion of granular grains. From the experimental fact of the low velocities of the lunar anorthositic rocks, we question the simple identification of the second layer in the lunar crust with the anorthositic layer (2). Based on the velocity data of the terrestrial anorthosite, the compressional-wave velocity of the crystalline, pore-free anorthosite is estimated to be about 7.0 km/sec which is the velocity observed in the lunar crust from 25 to 60 km. However, the anorthositic rocks from the lunar surface give the velocity smaller than 7.0 km/sec even at $P=10$ kb as shown in Table 1. In another word, the lunar anorthositic rock does not give the right velocity of the second lunar crustal layer by only the self-compression. Therefore if the lunar velocity profile by Toksoz et al. (2) is correct, the discontinuity at depth of 25 km must be textural one, though it may be coincident with the chemical discontinuity as proposed by Toksoz et al. The implication of the textural discontinuity at the depth of 25 km has been discussed by Simmons et al. (3).

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Thermal diffusivities were measured for a fine-grained basalt 73235,18 and an anorthositic gabbro 77017,20. The thermal diffusivity of the anorthositic gabbro is 1.5×10^{-3} cm²/sec at T=400 K and P=10⁻³ torr, whereas that of the lunar basalt is 4.6×10^{-3} cm²/sec at the same condition. The lower thermal diffusivity or lower thermal conductivity of the anorthositic rocks than that of the lunar basalt may have significant effect on the thermal state of the lunar interior. Since the crust of the lunar highland is believed to be anorthositic, the thermal conductivity in the highland is substantially lower than that in the mare region. Combined with the low concentration of radioactive elements in the highland (4), the lower thermal conductivity in the highland indicates higher temperature profile than that in the mare region, if the surface heat flow is same in the both regions (5).

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Table 1. Smoothed values of seismic-velocities of lunar rocks

		Pressure (kb)							
		0.0	0.5	1.0	2.0	3.0	5.0	7.0	9.0
61175,22	V _P		2.94	3.46	4.03	4.38	4.94	5.13	5.46
	V _S			1.92	2.19	2.37	2.64	2.91	3.09
70215,30	V _P	4.79	5.77	6.23	6.70	6.91	7.08	7.14	7.19
	V _S	2.48	3.10	3.33	3.56	3.67	3.77	3.80	3.81
73235,18	V _P	5.42	6.02	6.39	6.72	6.88	7.08	7.12	7.14
	V _S	2.95	3.32	3.48	3.66	3.77	3.86	3.90	3.92
74275,25	V _P	4.14	5.20	5.98	6.61	6.88	7.13	7.24	7.28
	V _S			2.98	3.66	3.82	4.04	4.09	4.11
77017,25	V _P	2.56	2.69	3.20	4.25	4.80	5.51	5.95	6.20
	V _S	1.78	1.86	2.01	2.30	2.60	3.03	3.33	3.45