SHOCK INDUCED ULTRA-SOUND ABSORPTION IN LUNAR ANORTHOSITE

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Ultra-sound absorption measurements under "lunar environmental conditions" have been carried out at lunar anorthosite sample 6oo15,33 with the aim to contribute to the understanding of the high Q derived from lunar seismograms.

A new technique, comparable to the reverberation measurements in room acoustics has been developed. This method allows Q-determination at rock samples of arbitrary shape in the frequency range 5o to 6oo kHz in vacuum (1o^{-4} torr) and at low temperatures (+2o^{o} to -18o^{o}C). The sample is acoustically isolated from its surroundings. A short impulse introduced by a piezoceramic transmitter causes the sample to vibrate. The same transducer serves thereafter as an acoustical receiver for the exponentially decaying reverberations. For more details of the basic principles of the method, the experimental set up, and the evaluation technique reference is made to Ch. Herminghaus and H. Berckhemer (1974) and J. Drisler and P. Antony-Spies (1974).

The result of Q-measurements at the lunar anorthosite in vacuum during repeated cooling and warming up at the frequencies 25o and 5oo kHz is shown in Figure 1. Compared with the Q(T)-curves of terrestrial silicate rocks (volcanics, gabbros, feldspars and quartz of different grain size and texture), the Q-values of the lunar anorthosite are lower and surprisingly temperature independent. No high Q-values, however, as required to understand lunar seismograms were found. This has to be explained.

One remarkable result of our experiments with terrestrial rocks was the fact that after rapid cooling in a spray of liquid nitrogen, Q of the sample shows an irreversible lowering together with a flattening of the Q(T)-curve. This effect is most pronounced for originally high-Q samples. The reduction after repeated temperature shocks is shown in Figure 2 for different terrestrial rock samples. For comparison with the lunar sample, the Q(T)-curves of a terrestrial anorthosite of almost pure anorthite is shown in Figure 3. Curve XIII shows Q(T) before and XXV after repeated temperature shock treatments. The lowering and flattening of Q(T) is clearly demonstrated. This effect must be caused by the increase of micro-crack density in the sample, which leads to absorption by friction at crack surfaces and disconnected grain boundaries. Apparently in non-ideal polycrystals this type of absorption plays an important role.

The similarity between curve XXV in Figure 3 and Figure 1 is striking. To test whether the low Q in the lunar rock is also the consequence of high microcrack density, the sample had been

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temperature shocked by a spray of liquid nitrogen. No difference in Q before (x) and after (·) this treatment can be observed. This is taken as a proof for a very high micro-crack density in this lunar surface rock sample. These cracks may have been created either by the multitude of temperature oscillations between lunar day and night and/or by meteoritic impact shock-waves. The importance of temperature induced microcracks, however, is pointed out by this paper.

References:

Herminghaus, Ch. and H. Berckhemer (1974): Ultra-sound absorption measurements in rock samples at low temperatures. Z.f. Geophysik (in press)

Drisler, J. and P. Antony-Spies (1974): Q of a reverberating solid. Z.f. Geophysik (in press).

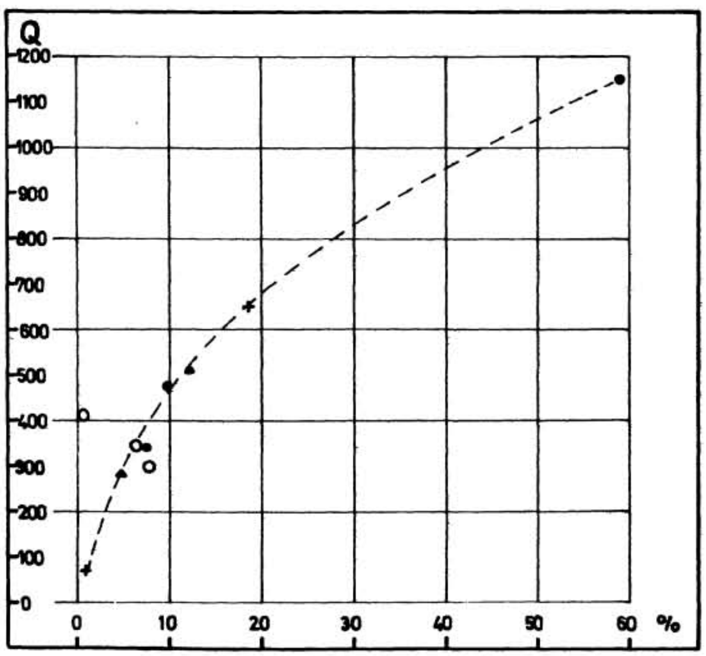

Fig. 2 Drop in Q (%) after temperature shock for rocks of different initial Q-values

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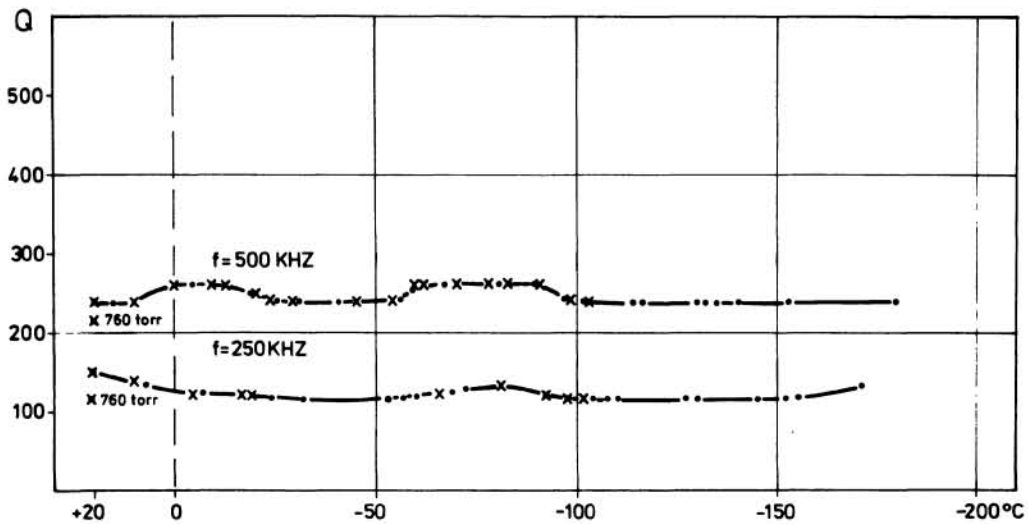

Fig. 1 Q(T) of lunar anorthosite sample 6oo15,33
before (x) and after (•) temperature shock

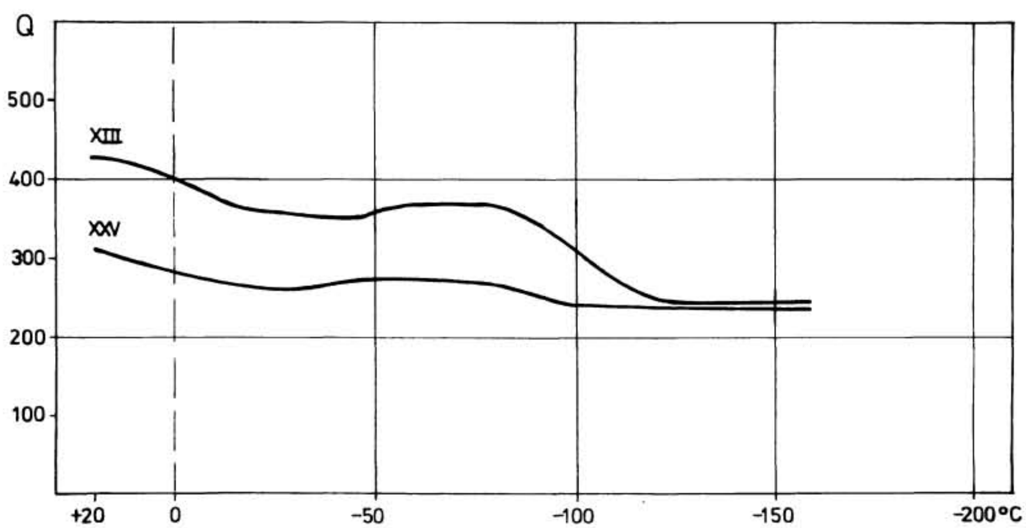

Fig. 3 Q(T) of a terrestrial anorthosite
XIII before and XXV after temperature shock treatment

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