MUSICAL SAND CHARACTERIZATION

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1. INTRODUCTION

Over the years, our research group and others have conducted several investigations into the properties of musical sands. It is generally agreed that a particular combination of factors such as composition, shape, texture, degree of sorting, moisture content and surface characteristics must be met in order to produce these peculiar sands. The present report will summarize some of the most significant observations made in studying this unusual effect; hopefully, this will benefit those readers who are similarly intrigued by this enigmatic phenomenon.

2. RESULTS

There are two types of musical sand: booming sand, generally found on desert sand dunes and singing sand, which appears on certain beaches. Studies on both types have revealed the following observations, features and properties:

<u>Acoustic:</u> These sands emit very intense sounds in the field when disturbed. Coherent sound from booming sand is sometimes so loud that it carries over several kilometers from a sand dune, sometimes accompanied by a recognizable beat. When small samples are shaken in a jar, they generate a rhythmic thrum of a few hundred Hertz, producing noticeable vibrations in the hand. Acoustic emission created by the rubbing of particles in motion features coherent beat patterns when displayed on a storage oscilloscope. (1) Time parameters of these signals have been related to sample and grain size. (2)

<u>Physical:</u> Musical sands are usually well-sorted with respect to size and shape. Electron micrographs show that their grains are moderately spherical and rounded and that grain surfaces appear smooth, clean and polished and contain a critical amount of moisture. Muteness of smooth, spherical and clean glass beads and other ordinary sands indicates however that regularity of size, shape and smoothness by themselves cannot account for musicality. (3) Solid infection experiments, whereby grains of silent sands are mixed with musical ones, show that surface contaminants as well as dampness quickly silence musical sands. Subdivision of field samples of musical sand into narrow size ranges has also revealed that no particular fraction has a monopoly on musicality.

<u>Chemical:</u> X-ray fluorescence tests have shown that the grain composition of musical sands is primarily quartzitic, although calcareous musical sands, which can never be as dry as desert ones, are found in Hawaii. Evidently the musical property is partly determined by a particular frictional force which is attained with little water for clean quartz grains, but requires some water absorption for calcareous ones. However, the presence of a thin silica gel-type surface layer on musical sand grains has been detected by Fourier transform infrared spectroscopy. A broad absorption band at 3400 cm^{-1}, extending from 3700 cm^{-1} to 2800 cm^{-1}, is due to clusters of water in an amorphous silica layer on the surface of the sand grains. (4) This has been confirmed by demonstrating that commercially available silica-gel materials, which give the characteristic 3400 cm^{-1} IR band, also produce an audio beat pattern typical of natural singing sands. (5) The composition and condition of the particle surface seem to play a very delicate role.

3. CONCLUSION

From the experiments reported above, it can be concluded that a combination of several agents is responsible for the musical sand phenomenon. In individual cases the presence of too much water, of finely divided material, or of grain angularity has a deleterious effect; but dry, clean and rounded grains by no means always sing and some sands with presumed high moisture content do sing. Smoothness has been shown to be important, but glass spheres smoother than any sand grain do not sing. It is likely that musicality is mediated by a very specific grain-grain surface interaction to which individual grains systems can be tuned in a variety of ways. It then becomes an accident of grain history and environment as to whether a combination of factors will be right for musicality to occur.

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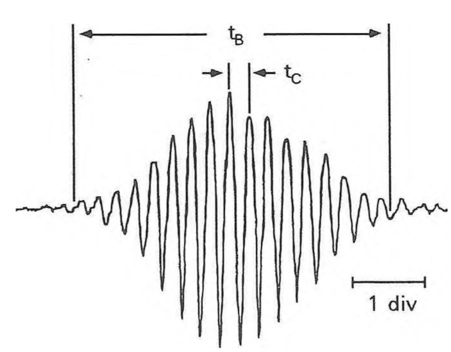

Typical Signal Emitted by Musical Sand