

Scientists Investigate Cause of 'Singing Dunes'

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Singing sand dune in Altyn-Emel National Park, Almaty Province, Kazakhstan.
Image credit: Jonas Satkauskas.

(PhysOrg.com) -- In more than 30 locations around the world, the phenomenon of singing sand dunes has intrigued explorers, tourists, and scientists. When an avalanche occurs or even when the sand is pushed by hand, it emits a powerful, monotonous sound that can last up to several minutes and be heard more than a mile away. Sometimes observers mistake the noise for a loud, low-flying aircraft. Although scientists have spent many years investigating the sound, the cause remains a mystery. Studies have suggested that the singing dunes phenomenon is a completely new way of generating sound.

Previously, researchers have narrowed down the possible causes of the

sound source. They found that the wind does not play an important role, since the same sound can be generated by a person moving sand around with their hands, or even in the lab. Also, scientists know that the sound isn't produced by the entire dune resonating (like a [musical instrument](#)), but by the motion of the sand grains themselves. However, different research teams have proposed contradictory explanations for the sand grain vibrations, ranging from stop-and-go grain motion to surface [waves](#) that synchronize the grain collisions.

In a recent study, Bruno Andreotti and L  n  d  c Bonneau of the Physique et M  canique des Milieux H  t  rog  nes (PMMH) in Paris, France, have further investigated the nature of the acoustic mechanism at the origin of the booming dunes. In their study published in a recent issue of *Physical Review Letters*, Andreotti and Bonneau have proposed an alternative explanation, in which friction between the layer of moving sand grains and the underlying layer of stationary sand dune creates elastic waves.

When testing their predictions against measurements taken during 50 controlled booming avalanches at Sidi-Aghfinir (Atlantic Sahara, Morocco), the scientists found that the elastic waves can propagate off the underlying static [sand](#) region in all directions. The waves emitted at the rear of the [avalanche](#) are later reinjected at the front through the sides, creating constructive interference and amplifying the waves. The reflection of an elastic wave on a frictional interface results in energy pumping from shearing motion to coherent acoustic waves, which is the source of the booming sound. As the scientists explain, the principle is similar to the light from a laser (light amplification by stimulated emission of radiation). In both cases, a cavity and an amplifier create a spontaneous emission of coherent waves.

“On the fundamental level, we have shown that any wave-guide whose interface presents a solid-like friction is unstable toward the spontaneous emission of vibration,” Andreotti told *PhysOrg.com*. “Applied to

booming dunes, we have, for the first time, written a model based on a clear and well-posed hypothesis. It predicts the amplification of seismic waves by the shear band separating the avalanche from the static part of the [dune](#), amplification that was directly evidenced in the field. This was a missing ingredient in former attempts to explain the [phenomenon](#).”

Andreotti added that, until scientists confirm exactly what is causing the dunes to make noise, it's difficult to say what kinds of applications the research may have.

“One does not know before doing the research if it is important or not: phenomenon like booming dunes can result from the cooperation of different complex specific mechanisms or point to a generic explanation that can be used in other fields,” he said. “Here, the coupling between a mean flow and vibrations may be important in applied fields (for instance, silo are well known to boom during their discharge, a phenomenon directly related to friction-induced seismic wave amplification) or to try to understand other fundamental problems like earthquake triggering.”

Since other researchers in the field have different ideas of how the dunes produce sound, Andreotti and Bonneau are interested to see how other teams will react to their new results.

“The subject is highly controversial,” Andreotti said. “So, we wait for the future works of other groups working in the field: will they confirm our theory and measurements? [Or] will they come up with a different theory?”

More information: B. Andreotti and L. Bonneau. “Booming Dune Instability.” *Physical Review Letters* 103, 238001 (2009).

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