What wears teeth out?

Jan 2013 – Dental microwear, the pattern of tiny marks on worn tooth surfaces, is an important basis for understanding the diets of fossil mammals, including early human ancestors and close relatives. Now nanoscale research by an international multidisciplinary group that included members of the Faculty of Dentistry and College of Engineering and Petroleum at Kuwait University has unraveled some of its causes. It turns out that quartz dust, the scourge at the heart of sandstorms, is the major culprit that abrades tooth enamel. Silica phytoliths, particles produced by plants, just rub enamel, and thus have a lesser effect on the enamel surface. The results suggest a revision of what microwear can tell us. East African hominins may have suffered during dust storms, some of which may even have been carried in by seasonal winds from the Arabian peninsula.

New research published in the *Journal of the Royal Society Interface* suggests that the main cause of the physical wear of mammalian teeth is the extremely hard particles of crystalline quartz in soils in many parts of the world. To show this, single particles were mounted on flat-tipped titanium rods and slid over flat tooth enamel surfaces at known forces. Quartz particles could remove pieces of tooth enamel at extremely low forces, meaning that, even during a single bite, these particles could abrade much of the surface of the tooth if they are present in numbers. In contrast, plant phytoliths, which are non-crystalline and much softer than quartz or tooth enamel, indented the enamel under the same conditions, but without immediate tissue removal. Their effect is similar to that of a fingernail pressed against a softwood desk. This kind of mark, called a rubbing mark, is visible but not a sign of immediate tissue loss. A new theory of wear, developed by collaborator Tony Atkins from Reading in the UK, suggests exactly what geometrical and material conditions are required for abrasive versus rubbing contacts. “People have not realized the vital importance of factoring fracture toughness into wear analyses” says Prof. Atkins. Kuwait University researcher Peter Lucas says “we think that we’ve gone a lot further with the analysis of microwear than previous investigations because we realized that to uncover the mechanisms that cause it, you need to go one level smaller – to nanoscale. It is only then that the difference between relatively innocuous rubbing contacts and those that remove tooth tissues becomes clear.” The team could distinguish between marks made by quartz dust, plant phytoliths and also by enamel chips rubbing against their parental surface.

The international team was led by authors from the Faculty of Dentistry and College of Engineering and Petroleum, Kuwait University, together with researchers from the Max Planck Institute for Evolutionary Anthropology (Germany), the University of Reading (UK) and the University at Albany (New York, USA). Says Kuwait University Engineering Professor Abdulwahab Almusallam, “The nanotech centre that we founded in Engineering and Petroleum at KU is ideally equipped to assist multidisciplinary studies like this. We’re happy that we can provide techniques for finding the answers to major biological issues. This particular study opens up a whole new area of investigation – dental nanowear.”

The article “Mechanisms and causes of wear in tooth enamel: implications for hominin diets” appears online today (Jan 9th, 2013) in the *Journal of the Royal Society Interface*.

*Lucas PW, Omar R, Al-Fadhalah K, Almusallam AS, Henry AG, Michael S, Arockia Thai L, Watzke J, Strait DS & Atkins AG. Mechanisms and causes of wear in tooth enamel: implications for hominin diets. *Journal of the Royal Society Interface.*

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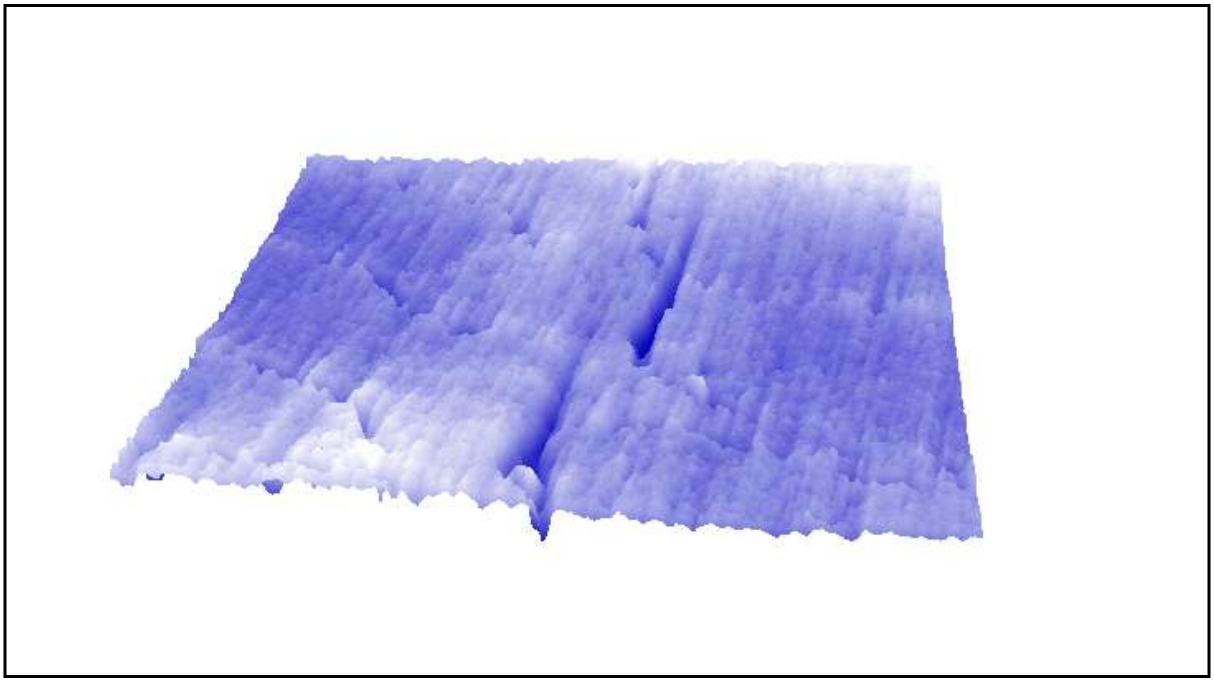

Parallel scratches on enamel, each 7.5 µm long and 12 nm deep, formed by dual contact with a quartz particle. Field width, 16 µm [AFM topographic image, courtesy of Lidia Thai]