**Introduction:** The surfaces of atmosphere-less solar system bodies are weathered in space by the action of several processes, such as the implantation of ions of the solar wind and the bombardment of micrometeorites. It is well known that these phenomena alter the spectroscopic properties of asteroids [1,2]. Here we describe the great effects of another process, whose importance has been considered only recently, that can alter the original surface nature of asteroids: the radiative heating by the light from the Sun.

In particular the surfaces of Near-Earth objects (NEOs) can easily reach temperatures $>$400 K, and the heat penetration depth is of the heat is in the order of some centimetres [3]. At perihelion distances $(q)$, smaller than 0.5 AU temperatures can be $>$550 K leading to the breakup of organic components (e.g. 300–670 K [4,5]). The knowledge of the temperature range of materials at different depth over the orbital evolution of space mission target asteroids is important for defining sampling strategies that ensure the likelihood that unaltered and pristine material will be brought back to Earth [6].

There are for instance NEOs with extremely close Sun approaches, such as the asteroids 3200 Phaethon and 1566 Icarus. Temperature on these asteroids can reach 1000 K, inducing mineralogical changes, thermal fracture and/or desiccation cracking and the production of dust particles. In particular, 3200 Phaethon is the parent body of the Geminids meteors and activity near perihelion has been detected for this asteroid [7].

Moreover, the surfaces of NEOs are also subject to large temperature variations (e.g. 150 K): these are due to the change of the insolution intensity caused by the diurnal cycle between day and night, by seasonal effects, by the orbital eccentricity or simply by a shadowing effect. Are the surface make up and mineralogy of these asteroids altered by these strong temperature variations?

**Experimental and theoretical analysis:** It is known that temperature cycles can lead to mechanical load cycles inducing stresses in surface rocks. Cracks can thus form and propagate due to temperature variations and the resulting temperature gradients set up by the thermal cycles. Several works have suggested that such thermal fatigue may play an important role in the evolution of airless landscapes on bodies such as the Moon, Mercury, and on the asteroid Eros [8,9,10].

Here we will describe laboratory experiments and numerical modeling devoted to investigating whether thermal fatigue is active on asteroid surfaces. Laboratory experiments of thermal cycling (Fig. 1) were performed on meteorites - taken as analogues of asteroid surface material - to study under which conditions rock cracking on NEAs occurs and how this process may alter asteroid surfaces.

![Fig. 1. CO$_2$ pulsed laser thermal fatigue experiments on the same Murchison CM2 carbonaceous chondrite sample after 2 and 128 thermal cycles ($\Delta T\approx 180$K).](image)

**Discussion:** Our results [11] demonstrate that thermal fatigue is a dominant process governing regolith generation on small asteroids. We find that thermal fragmentation induced by the diurnal temperature variations breaks up rocks larger than a few centimetres more quickly than do micrometeoroid impacts. Because thermal fragmentation is independent of asteroid size, this process can also contribute to regolith production on larger asteroids. Production of fresh regolith originating from thermal fatigue fragmentation may be an important process for the rejuvenation of the surfaces of near-Earth asteroids. The efficiency of thermal fragmentation is controlled by the amplitude of the temperature cycles and by the temperature change rate, which in turn depend on heliocentric distance, rotation period, and the surface thermal inertia.