The material almost certainly comes from dark asteroids in the main belt, because asteroids can be ground down to micrometeorite particles by mutual collisions over billions of years. The idea that similar exogenic material coats other large asteroids has yet to be tested. However, perplexing spectral signatures of hydrated minerals, consistent with volatile-rich carbonaceous materials, have been found on objects that would otherwise be interpreted as metallic[4,5] or inconsistent with the presence of stable volatile compounds[6]. In fact, almost a decade ago, astronomers using ground-based telescopes detected evidence of hydrated minerals on Vesta itself[7]. At the time, those measurements were considered suspect, but they now seem to be vindicated by the Dawn results.

Are the carbonaceous materials found on Vesta the result of low-velocity impactors? The fate of a rocky impactor depends in part on its velocity relative to the speed of sound in the rock. Carbonaceous materials have relatively high porosities[8]. Therefore, sound waves travel through them slowly and impact-associated shock-wave pressures may be quite low, favouring the survival of large fractions of such impactors. Without high shock-wave pressures, much less material might be vaporized and lost to space[9]. McCord *et al.* present estimates of impactor fluxes and of the amount of impactor material that Vesta has accumulated (see Supplementary Information to the paper[1]). On the basis of these estimates, they conclude that sufficient material has been deposited on the Vestan surface to cover it with a blanket up to about 1–2 metres deep.

The delivery of exogenic material is not generally what comes to mind when considering space weathering. The term is used to refer to processes that change the optical properties of the remotely sensed surface of an airless body. Studies of lunar soils and rocks brought back by the Apollo-mission astronauts have provided important information about space weathering on the Moon. Furthermore, direct evidence of space weathering on asteroids was supplied by the NEAR mission to the near-Earth asteroid 433 Eros[10] and by the Hayabusa mission to asteroid 25143 Itokawa[11].

Before the Dawn-mission findings, the consensus was that some lunar-like space weathering occurs on asteroids[12–14], and that its strength depends on the composition of the target material — that is, the material from which the asteroid is made. In the leading model of asteroidal space weathering, condensates bearing submicroscopic iron are deposited on grain surfaces after the target material has been vaporized by solar-wind sputtering and micrometeorite bombardment. Space weathering is known to cause surface darkening and spectral changes, and so these processes and their effects must be considered when interpreting the spectral properties of airless bodies. According to Pieters and colleagues, two other processes should now be considered when trying to explain the Dawn observations of Vesta: the mobility of regolith (powdery rubble that covers a planetary body) and fine-scale mixing of surface material. Therefore, the results prompt two questions. Why does Vesta not exhibit lunar-like space weathering? And was our model wrong, or do the weathering processes compete with each other?

The goal of the Dawn mission is to characterize the conditions and processes that were active during the Solar System's earliest epoch by investigating Vesta and Ceres, two of the largest asteroids that are still intact. Dawn has completed its tour of Vesta and will arrive at Ceres in February 2015 to send back data on that asteroid's low-brightness surface. It will be interesting to see whether these observations allow us to distinguish Ceres' bulk material from the 'rain' of carbonaceous material that may be contaminating its surface. ■

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NEUROSCIENCE

Sleep to oblivion

These days, it is hard to imagine having a surgical procedure without anaesthetics. Yet some 170 years after their first use in medicine, the way in which these drugs exert their hypnotic effects remains a mystery. Writing in *Current Biology*, Moore *et al.* shed light on the question (J. T. Moore *et al. Curr. Biol.* http://dx.doi.org/10.1016/j.cub.2012.08.042; 2012).

Many biological molecules are sensitive to anaesthetics, among them membrane ion-channel proteins. To make matters more complex, there are dozens of anaesthetic agents, and yet they don't seem to share a single molecular target. An emerging theory is that these drugs inhibit the neural circuitry associated with wakefulness. Moore and colleagues asked whether they also affect sleep-promoting neurons.

The authors focused on the anaesthetic agent isoflurane and its effects on the ventrolateral preoptic nucleus (VLPO) — a key component of the arousal (wakefulness) neurocircuitry. Neurons of the VLPO are active during sleep and, in response to inhibitory neuromodulators such as GABA, they inhibit signalling by downstream arousal-promoting neurons. Moore *et al.* find that concentrations of isoflurane that induce sedation or anaesthetic hypnosis also activate VLPO neurons, just like sleep does. Moreover, damaging these neurons reduces the hypnotic effects of isoflurane.

Of the two neuronal subpopulations that form the VLPO, only one is thought to be involved in promoting sleep. By studying slices of mouse hypothalamus — the brain region in which VLPO neurons are found — Moore and colleagues show that isoflurane specifically activates the sleep-promoting subpopulation. Exactly how it does so is unknown, but the researchers' data indicate


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that a reduction in the conductance of potassium ions is involved.

The authors do not rule out a role for other sleep-promoting neuronal circuits in mediating the effects of anaesthetics. But their take-home message is that, to understand how anaesthetics act, studying sleep induction is probably just as useful as investigating the inhibition of wakefulness.
Sadaf Shadan