Sulfur, sulfur dioxide and graphitized carbon observed on asteroid for first time

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Images of Ceres made using combined Dawn and 2005 HST ultraviolet-visible wavelength images. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA/Philip Stooke/Ian Regan

Hubble Space Telescope observations of the dwarf planet Ceres have discovered the first evidence of sulfur, sulfur dioxide and graphitized carbon found on an asteroid. The sulfur species are likely associated with regions of recent activity, reports Planetary Science Institute Senior

Scientist Amanda Hendrix.

The discoveries were made by comparing Ceres' ultraviolet-visible spectra to laboratory measurements and are presented in the paper "Ceres: Sulfur Deposits and Graphitized Carbon" that appears in the journal *Geophysical Research Letters*.

Planetary Science Institute Senior Scientists Faith Vilas and Jian-Yang Li are co-authors.

The new HST observations are complementary to observations being made by instrument on the Dawn spacecraft in orbit at Ceres, covering additional wavelengths.

The presence of graphitized carbon is consistent with weathering of carbonaceous material on the asteroid's surface, caused by processes such as charged particle bombardment.

"For the first time, a carbon-rich asteroid has been observed in the spectral region where graphitized carbons show unique spectral features," said Hendrix. "Other dark asteroids probably have graphitized carbon on their surfaces as well."

"This is a window to evidence of the effects caused by direct exposure to space for a primitive asteroid surface," said Vilas.

"Both sulfur and SO2 are volatile species at typical Ceres temperatures – they aren't likely to stick around for long before they sublimate and are lost to space. These species could also migrate to cold regions on Ceres, such as some shadowed craters, where they are stable," said Hendrix. "The presence of these volatile species on the surface suggests that they have recently been emplaced, perhaps by some sort of geothermal activity. Both Dawn observations and Herschel Space Telescope

observations have suggested recent activity at Ceres, so it may be that sulfurous materials are involved in the activity."

"It is remarkable that Ceres has this graphitized carbon covering much of its surface – which tells us that it's been exposed to weathering processes for eons – and yet Ceres also shows evidence of relatively young, fresh materials as well," said Hendrix.

"With two space probes planning to rendezvous with dark, carbon-rich asteroids in the next few years, these Ceres observations are helping us to build a good foundation for our understanding of these type of bodies," Vilas said.

Ceres is the largest object in the main asteroid belt, and, along with Pluto, is classified as a dwarf planet.

More information: Amanda R. Hendrix et al. Ceres: Sulfur deposits and graphitized carbon, *Geophysical Research Letters* (2016). DOI: 10.1002/2016GL070240

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