PHILAE'S
FIRST DAYS ON THE COMET

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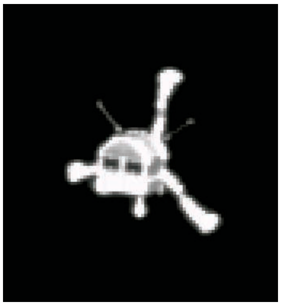
On 12 November 2014, Philae landed on the surface of comet 67P/Churyumov-Gerasimenko (67P), making an almost 30-year dream a reality. The pioneering flybys of 1P/Halley in 1986 revealed that despite being made primarily of ice, it was covered in highly absorbing carbon-rich molecules. What is their composition? When did they form, and through which chemical routes? Might they have constituted prebiotic molecules necessary for life? At a larger scale, what can one learn from comets that has relevance to the evolution of the solar system and planets?

To address such questions, the Rosetta mission sought to perform a broad range of in-depth structural, physical, and chemical measurements from remote, in situ, and landed vantages. The candidate payload opened for a competitive selection included an instrumented Surface Science Platform (SSP). The initial two that were selected later merged into what is known as Philae, instrumented by 10 principal investigators selected by the SSP providers. The Philae platform and payloads were developed and operated by a highly integrated consortium of institutes, agencies, and industries.

Philae's scientific objectives were to provide ground-truth information and complement remote measurements performed from the Rosetta orbiter (*Science* **347**, 23 January 2015) and to offer a self-standing suite of in situ measurements never before performed on a comet. This issue presents a first set of results acquired aboard Philae in the first 63 hours after it separated from Rosetta, descended, initially touched down on the comet at the site known as Agilkia, and finally came to rest at the site known as Abydos.

The release and descent happened as planned, precisely documented by imaging (Mottola *et al.*), ranging (Kofman *et al.*), thermal mapping (Spohn *et al.*), and the evolution of the magnetic properties (Auster *et al.*). The prospect of landing on such an alien body, at 515 million km from Earth and 3 astronomical units (AU) from the Sun, was far more challenging than imagined. The unexpected bounce at touchdown required a major reshuffling and adaptation of the first sequence of science operations. It also provided the opportunity for additional measurements, whereas the bouncing and traversing constrained the mechanical (Biele *et al.*) and magnetic properties of the surface.

ROLIS imagery at its highest resolution (1 cm per pixel) showed the surface of the comet near Agilkia to be dominated by the presence of granular material free of any dust deposits (Mottola *et al.*). Regolith mobilization processes appear to be involved with the formation of these features. Once Philae came to rest at Abydos, the revised first science sequence began. CIVA panoramic images characterized the surrounding cometary material down to the millimeter scale and the attitude of Philae at rest (Bibring *et al.*). The MUPUS package measured and constrained the thermal and mechanical properties of the near-surface material of the comet surface at Abydos (Spohn *et al.*), indicating that the near-surface layers consist of a hard dust-rich sintered ice, possibly covered by a thin dust layer. The CONSERT bistatic radar provided an opportunity to investigate the comet's internal structure (Kofman *et al.*). The upper "head" of 67P is fairly homogeneous on a spatial scale of tens of meters. The average permittivity provides ranges of the volumetric dust/ice ratio and the internal porosity. The dust component may be comparable, from the dielectric properties, to that of carbonaceous chondritic meteorites. COSAC and Ptolemy independently measured the composition of the volatile constituents of the grains lifted at touchdown and of the species outgassed at the final landing site (Goesmann *et al.* and Wright *et al.*). The grains are primarily made of carbon-rich species in a complex suite of molecules, including precursors to some biomolecules and other compounds never before identified in comets.



12 NOVEMBER 2014: PHILAE LANDED ON THE NUCLEUS OF COMET 67P

Taken together, these first measurements performed at the surface of 67P profoundly modify our view of comets. 67P is nonmagnetized on a scale of less than a meter, with its surface layers composed of both sintered ices, which are hard in nature, and fluffy grains and pebbles of organic materials, possible remnants from the era of comet formation itself. Although it remains to be seen whether these observations hold true for all comets, the discoveries made by Philae—including these initial results—will continue to shape our view of the history of the solar system.

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