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Coma chemical composition at the Abydos landing site

A. Morse, S. Sheridan, G. Morgan, D. Andrews, S. Barber, I. Wright
Department of Physical Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK.
(andrew.morse@open.ac.uk)

Abstract

The Ptolemy instrument, onboard the Rosetta Philae Lander, made measurements of the chemical composition of the coma mid-bounce, just after the non-nominal landing on the surface, and subsequently at the Abydos landing site. This presentation will discuss Ptolemy's operations throughout this 45 hour period and the results obtained.

1. Introduction

Ptolemy is a Gas Chromatograph – Mass Spectrometer onboard Rosetta's Philae Lander [1]. Philae initially landed at the Agilkia landing site on 12th November 2014, bounced and finally came to rest at the Abydos site some 1½ hours later. Ptolemy is primarily designed to analyse volatiles released from solid comet samples collected by the SD2 drill [2] following heating in an oven. However, it can also operate in a "sniff" mode where the local gas environment is analysed directly. Despite the non-optimal landing, the Ptolemy instrument made six measurements of the coma gas at the comet surface over the following 45 hours. These analyses provide ground truth measurements of the coma gas pressure and composition at the Abydos location on the surface of the comet. The concentrations of the main chemical components give insights into the nature of the sublimation regions of the comet.

2. Ptolemy operations

The timeline of measurement made by Ptolemy is shown in Table 1. All analyses were made at the Abydos site, apart from the first measurement, which made 20 minutes after the initial touchdown whilst Philae was mid-bounce. As a consequence of the non-nominal landing, Philae was commanded to execute the pre-programmed Safe Block of measurements. This Safe Block was restricted to measurements that did not require any movement of the Lander or mechanical mechanisms such as the SD2 drill, MUPUS penetrator or APXS. However the Safe Block did include a total of four Ptolemy coma gas measurements, at two hour intervals, during which time the Abydos site passed from illumination into night.

Table 1: Timeline of Ptolemy "sniff" operations after Philae initial touchdown (TD)

Date	Time (UTC)	Ptolemy Temp. (°C)	Comments
12-Nov	15:54	0	20 minutes after TD
13-Nov	06:35	0	Comet day
	08:37	-2	Comet dusk
	10:39	-2	Comet night
	12:41	-4	Comet night
14-Nov	02:54	-17	Comet night
	12:36	-23	Comet night

3. Results

The mass spectra acquired at Abydos had peaks attributed to three main components: water, carbon monoxide and carbon dioxide. Carbon monoxide has an isobaric interference with nitrogen, both with a mass/charge ratio of 28. However, the nitrogen concentration is thought to be a minor component as there was no fragment peak at m/z 14. Furthermore, on the orbiter the ROSINA [3] mass spectrometer, which has sufficient resolving power, has measured a very low N_2/CO ratio of less than 0.01 [4].

The coma gas concentration at Abydos was much lower than the average coma concentration measured by ROSINA. The initial measurement made by Ptolemy in comet day was about a factor of 10 less than that of the average gas concentration and the concentration decreased even further during the comet night.

The measurement at Agilkia had similar CO and CO_2 concentrations relative to the more abundant water. However, there were much higher levels of organic compounds present, which is attributed to the disturbance of the surface layer by the Lander impact.

4. Discussion and future operations

The coma composition at the surface reflects the sub-surface sublimation processes occurring within a localized area. The low coma pressure indicates that Abydos is a low activity region. The ratios of the main components suggest that the more volatile species may already have been depleted at this location.

As the comet approaches perihelion we hope that Philae will survive the hibernation and have sufficient power to begin instrument operations. The Ptolemy "sniff" mode is low power (<5W) and duration (<10 minutes). Also, the mode has been modified to improve the scientific and data return rate. When Philae wakes up the coma will be much more active and the greater solar irradiation will result in sublimation occurring at greater depths. Measuring changes in coma composition will give insights into the subsurface composition and processes occurring on the comet surface.

5. Summary and Conclusions

Ptolemy made measurements of the coma gas composition as it left Agilkia and at the Abydos site of comet 67P/Churymov-Gerasimenko. Results indicate that this is a low activity region depleted of volatiles. Further measurements, made as the comet approaches perihelion would sample the sub-surface at greater depths and give insights into the sublimation processes occurring on the comet.

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