***ROSETTA*: EVALUATING THE POSSIBILITY OF USING *PTOLEMY* FOR PRE-LANDING SCIENTIFIC INVESTIGATIONS.** I.P.Wright, D.J.Andrews, S.J.Barber, S.Sheridan, G.H.Morgan and A.D.Morse. Planetary & Space Sciences, The Open University, Walton Hall, Milton Keynes. MK7 6AA UK. (i.p.wright@open.ac.uk).

Introduction: Launched in 2004, the *Rosetta* spacecraft [1], which is en-route to rendezvous with, and land on, comet 67P/Churyumov-Gerasimenko [2], will awake from its current deep space hibernation on January 20th, 2014 (i.e. by the time of the conference it will be known whether this was successfully completed or not). Our abstract for the 44th LPSC [3] describes some of the operations that will hopefully accompany the phase of the mission where the lander element, *Philae* [4], is ejected from the main spacecraft, directed towards the comet, and ultimately anchored to its nuclear surface. The *Ptolemy* instrument, which is designed to undertake elemental and isotopic analyses of surface materials, will be operational during on-comet investigations; indeed, this is its raison d'être. However, as was witnessed during the fly-by of asteroid 21 Lutetia, *Ptolemy* can also be operated in a remote, stand-alone capacity, i.e. in space, as opposed to being on the surface of any particular body [5,6]. Based on this experience we have been evaluating the possibilities of using *Ptolemy* for scientific investigations of the cometary coma *prior* to the separation of *Philae* from the orbiter craft.

***Ptolemy*:** As described previously [3,7] the instrument is a miniature analytical laboratory intended to determine the chemical and isotopic composition of cometary material sourced from beneath, on and above the surface of the target comet. In detail, the instrument has been designed to work with liberated volatiles and determine their concentration, chemical and accurate isotopic compositions (D/H, $^{12}C/^{13}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$ and noble gases). The primary intended purpose of *Ptolemy* is to analyse solid materials taken from the Sampler, Drill and Distribution system (SD2); these are heated in discrete increments of temperature, and any evolved volatiles ultimately passed to a quadrupole ion trap mass spectrometer for detection and quantification. As well as analysing solid samples, *Ptolemy* can passively adsorb coma material onto molecular sieve contained within one of the 26 SD2 sample ovens for later thermal release and analysis (we refer to this as "CASE" mode). *Ptolemy* can also make direct "sniff" detections of the current spacecraft environment via a vent pipe. As reported previously [5,6] we were able to evaluate the performance of parts of the instrument during a campaign of activity accompanying the fly-by of 21 Lutetia, where we used *Ptolemy* to investigate the possible existence of an asteroidal exosphere. For this, the flight-demonstrated mass range of the mass spectrometer (10-140 Da) was particularly suited for detecting volatiles such as water, CO_2 and organics. *Ptolemy* made "sniff" measurements several hours either side of close approach (to provide background data), and near to closest approach whilst over the sub-solar point of the asteroid's surface. Although the results showed no unambiguous detection of an exosphere, the total ion counts seen for differing mass spectral ranges (11-90 Da and 20-140) showed a rising and falling trend in the apparent pressure of the spacecraft environment.

Pre-Landing Science: The desire to conduct scientific investigations of the coma can be distilled down to a simplistic issue: how do measurements of a comet made from afar relate to the pristine nuclear materials on the ground? In principle, if one understands this relationship then clearly it is possible to cross-calibrate coma measurements (which are considerably less risky to make) with what actually exists at the cometary surface (i.e. which, ostensibly, represent the true cometary composition unaffected by processes of coma evolution, subsequent interactions of volatiles, isotopic exchange, etc.). Our hope is that within the scope of the entire mission it will be possible to make such comparisons between data acquired from the surface, by *Ptolemy* (and, indeed, another analytical instrument known as *COSAC*) and instruments on the orbiter such as *ROSINA* [8], which have the capacity to operate for much greater periods of time than those devices included on *Philae*. But, we believe that perhaps the most complete comparison arises from an opportunity to run *Ptolemy* in its "sniffing" and CASE modes as it approaches the comet (i.e. at pre-defined distances), as well as then being able to operate the instrument at the cometary surface. It is this possibility that we are currently exploring with our colleagues who are involved with the various aspects of mission operations.

Challenges of interpretation: Although easily stated, the question of calibrating coma and nuclear analyses is nonetheless fraught with difficulties once the true nature of the comet is pondered further. For instance, on-comet investigations of *Philae* will necessarily be confined to one particular area; this may, or may not, be representative of the whole. Furthermore, it is apparent that the very surface of a comet is itself highly evolved; the low albedos in evidence are symptomatic of the fact that during successive perihelion passages, surfaces become enriched in refractory, highmolecular weight organic compounds (veritable "tarry" materials, black in colour), as ices are selectively lost by thermal processing (a phenomenon nicely predicted by Greenberg prior to the arrival of *Giotto* at Halley [9]). There is yet a further issue to contemplate when considering the analysis of surface materials in situ. And that is, the extraction/analysis process itself may alter the pristine state of the material. Assuming that comets are indeed the embodiment of a collection of pristine materials, then under the temperature and conditions prevalent in their parent bodies, the subcomponents may have survived for all time in a state of disequilibrium (i.e. since the formation of the icy bodies that we now see as comets). Somewhat perversely, the conditions required to evolve the subcomponents for analysis may subject them to the same processes that ensue during the natural one of coma formation. In other words, it may transpire that coma volatiles look similar (in terms of molecular and isotopic compositions) to those that are presented to the analytical instruments on the surface. It is for reasons such as this that we need to finesse our thoughts regarding the actual cometary encounter itself. And, almost inevitably, the more comprehensive we can make the analytical campaign, the better.

Summary: By the time of the 45th Lunar and Planetary Science Conference, the *Rosetta* spacecraft should be out of hibernation and beginning to approach comet 67P/Churyumov-Gerasimenko. Although we are currently busy defining our sampling strategies, which are inevitably based on what we expect and, of course, what is possible, we must remain open to the fact that we are dealing with something that is (at least, at the time of writing) still largely unknown.

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