Looking for Astrobiological Signatures with Penetrators on Europa

Robert Gowen[1], Alan Smith[1], Richard Ambrosi[6], Olga Prieto Ballesteros[16], Simeon Barber[2], Dave Barnes[11], Chris Braithwaite[9], John Bridges[6], Patrick Brown[5], Phillip Church[10], Glyn Collinson[1], Andrew Coates[1], Gareth Collins[5], Ian Crawford[3], Veronique Dehant[21], Michele Dougherty[5], **Julian Chela-Flores**[17], Dominic Fortes[7], George Fraser[6], Yang Gao[4], Manuel Grande[11], Andrew Griffiths[1], Peter Grindrod[7], Leonid Gurvits[19], Axel Hagermann[2], Tim van Hoolst[21], Hauke Hussmann[13], Ralf Jaumann[13], Adrian Jones[7], Geraint Jones[1], Katherine Joy[3], Ozgur Karatekin[21], Günter Kargl[20], Antonella Macagnano[14], Anisha Mukherjee[5], Peter Muller[1], Ernesto Palomba[12], , Tom Pike[5], Bill Proud[9], Derek Pullen[6], Francois Raulin[15], Lutz Richter[18], Keith Ryden[2], Simon Sheridan[2], Mark Sims[6], Frank Sohl[13], Joshua Snape[7], Paul Stevens[10], Jon Sykes[6], Vincent Tong[3], Tim Stevenson[6], Werner Karl [5], Lionel Wilson[2], Ian Wright[2], John Zarnecki[2].

1: Mullard Space Science Laboratory, University College London, UK email: rag@mssl.ucl.ac.uk. **2**: Planetary and Space Sciences Research Institute, Open University, UK. **3**:Birkbeck College, University of London, UK. **4**: Surrey Space Centre, Guildford, UK. **5**: Imperial College, London, UK, **6**: University of Leicester, UK. **7:** University College London, UK. **8:** University of Lancaster, UK. **9:** Cavendish Laboratory, Cambridge, UK. **11:** University of Aberystwyth**,** UK. **12:** Istituto di Fisica dello Spazio Interplanetario-INAF, Roma, Italy. **13:** DLR, Berlin, Germany. **14:** Institute of Microelectronics and Microsystem-CNR, Roma, Italy. **15:** Université Paris, France. **16:** Centro de Astrobiologia-INTA-CSIC, España. **17:** Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy. **18:** DLR, Bremen, Germany. **19:** Joint Institute for VLBI in Europe (JIVE), Dwingeloo, The Netherlands. **20:** IAF, Space Research Institute, Graz, Austria. **21:** Royal Observatory, Belgium

Europa, along with Mars and Titan, is considered a prime candidate for the presence of extraterrestrial life in the solar system. Although without a significant atmosphere, but which includes trace amounts of molecular oxygen, and very cold surface temperatures around 40-120K, it is widely believed that Europa hides a liquid salty water ocean kms under its icy crust warmed by enormous tidal forces from Jupiter, with a rocky mantle beneath (ref.1). Such a subterranean ocean, shielded from massive surface radiation, make it a good habitability candidate for indigenous life.

Furthermore, the Europan surface features a plethora of apparently young, colourful fissures consistent with the egress of potential astrobiological material upwelled from the ocean beneath, which could be investigated either remotely or in-situ for signatures of life. In particular, this material appears to be rich in sulphur which offers the opportunity for determination of the isotopic proportions of sulphur, either remotely or in-situ, capable of differentiating between inorganic and biological origin (ref.2). This is relevant to the search for life on exoplanets, since evidence of high external radiation need not be an excluder of the presence of life.

Penetrators proposed for Europa (ref.3) involve delivering small projectiles at high velocity to just beneath the surface ice, where the destructive effects of radiation are greatly reduced. This provide a means for both direct sampling, and remote sensing of potential astrobiological material with stand-off distances of the order of centimetres rather than interstellar distances as for exoplanets. However, since spectrographic signals are preserved through long space transits, this may offer the possibility for detection of common astrobiological signatures, though sensitivity may be an issue. Direct astrobiological investigations of samples collected by the penetrators will also be presented, to allow other potential insights for remote observations of life signatures from exoplanets.

R1: *Carlson, R. W., Johnson, R. E. and Anderson, M. S. 1999, Science, 286, pp. 97-99.*
R2: *Chela-Flores J. and Kumar N. 2008, International Journal of Astrobiology,* ***7,*** *(3), pp. 263-269.*
R3: *Penetrator website: http://www.mssl.ucl.ac.uk/planetary/missions/Micro_Penetrators.php*