ON THE PROPERTIES OF XYLAN, A LUBRICANT PAINT USED IN THE DRY-NITROGEN SAMPLE-HANDLING CABINETS AT NASA-JSC; I.P.Wright, C.P.Hartmetz, S.S.Russell, S.R.Boyd and C.T.Pillinger, Dept. of Earth Sciences, Open University, Walton Hall, Milton Keynes, England, and C.Meyer, NASA, Johnson Space Center, Houston, Texas, U.S.A.

During an investigation of EET A79001, a meteorite of probable martian origin, Wright *et al.* (1) uncovered an unexpectedly high concentration of material with the combustion characteristics of organic compounds. Since the meteorite was collected in Antarctica and handled with utmost care at NASA-JSC, it was tacitly assumed that contamination on Earth, or during sample processing, was an extremely unlikely explanation for the observed effect. However, a possibility requiring evaluation is that the sample in question contained some of the fluorocarbon-based substance called xylan, a lubricant used in the dry-nitrogen cabinets at JSC (this material is known to flake away from its application sites). Herein xylan has been analysed for its carbon and nitrogen content and isotopic compositions in order to assess whether this material could explain the results obtained from EET A79001.

Background. Prior to the return of lunar materials from the Apollo missions it was anticipated that samples would be processed on Earth under vacuum conditions. In order to prevent galling/freezing of screw-threads within the vacuum chamber, moveable components were coated with a non-organic lubricant, originally MoS_2, chosen at the behest of the organic community. After the initial experience of sample processing, vacuum conditions were deemed impractical and instead it was decided that handling would take place under dry-nitrogen. MoS_2 was still used as a lubricant on appropriate screw-threads until 1972 when a lubricant known as xylan 1010 was substituted. The exact reasons for this choice are somewhat obscure. The continued usage of xylan seems to have been endorsed under the misapprehension that it was a pure fluorocarbon product similar to poly-tetrafluoroethene (PTFE). The exact nature of xylan is somewhat more complicated and with hindsight seems to have been a poor choice for a lubricant.

Xylan 1010. Xylan is a proprietary industrial coating material supplied in resin form by the Whitford Corporation, U.S.A. This material is not a totally fluorinated polymer but a cocktail of components, including PTFE and various polyimide and polyamide structures suspended in a variety of solvents (ethyl acetate, xylene, dimethylformamide, N-methyl 2-pyrrolidone *etc.*). Following application, the partially-polymerised PTFE-polyimide resin is cured at 230°C to drive off the solvents, thereby converting the resin into a more highly polymerised polyimide-amide substance containing mechanically entrapped PTFE. Unfortunately the cured xylan tends to flake rather easily. Thus, during the operation of screw-threaded components, such as "lab-jacks", air-lock doors *etc.*, xylan may become dislodged and therefore, has the potential to contaminate any samples which may pass through the dry-nitrogen cabinets. It should also be noted that the flakes of xylan also include ferromagnetic materials, *i.e.* small quantities of metal (obviously not stainless steel, or aluminum) which have abraded off the screw-threads. Clearly xylan is not entirely effective for the task it was originally intended.

Carbon and nitrogen analyses. The protocol used by staff at NASA-JSC for servicing the dry-nitrogen cabinets involves the collection and storage of all materials extracted during routine cleaning. Herein collections of the finest xylan flakes retrieved from the lunar cabinets were taken for analysis (it is assumed that xylan from the meteorite cabinets exhibits similar properties). Sealed-tube combustion determination at 1000°C shows xylan (*sensu lato*) to contain 45 wt% carbon and 4 wt% nitrogen; analysis by analytical SEM shows that the only other major element present is fluorine (although clearly xylan will comprise a certain amount of oxygen and perhaps hydrogen). The $\delta^{13}C$ and $\delta^{15}N$ of xylan are -34.2 ± 0.2‰ and +0.3 ± 0.1‰, respectively.

Implications for organics in EET A79001. Of interest here is the behavior of xylan during stepped combustion since this will allow comparison with data acquired from EET A79001 and, in particular, sub-sample 239 (referred to hereafter as E,239). During stepped combustion of xylan, only 40.5 wt% carbon and 3.3 wt% nitrogen are released, demonstrating the difficulty of quantitatively burning fluorocarbons with this technique. The carbon release shows a geometric median at ~468°C, which is very similar to that which can be calculated (~457°C) for the putative organics in E,239. However, the release of carbon from xylan occurs over a very narrow temperature interval (-23 to +19°C of the median for 50% of the carbon release) compared to organics in E,239 (-117 to +94°C). Indeed the very broad release of carbon from the latter suggests the presence of more than a single component in E,239. Additional understanding of the potential influence of xylan contamination in E,239 comes from nitrogen measurements. E,239 contains 28 ppm of nitrogen, but since the release pattern of nitrogen is complicated, a maximum of only 11 ppm N could be due to xylan. The C/N_{atomic} ratio of xylan determined by sealed-tube combustion is equivalent to 13. Thus, based on the nitrogen measurements of E,239 it can be seen that a maximum of 143 ppm of carbon could be from xylan. This is almost an order of magnitude less than the concentration of carbon thought to be due to organic materials in this sample (1180ppm, ref. 1). Thus, it is concluded that xylan contamination cannot easily explain the unexpectedly high concentration of organic materials in E,239.

Comment. Xylan is an unnecessary potential contaminant; its further usage as a lubricant in sample processing cabinets is to be deprecated. Indeed, steps were taken during 1989 to eradicate it completely from the dry-nitrogen cabinets at JSC. However, further possible sources of organic contamination have now been identified. For instance, if a meteorite is sliced using the band-saw apparatus, it is possible that fragments of abraded viton may become imparted to the sample. To pursue this further, sawings, obtained when EET A79001 was cut open to reveal E,239, have been acquired for the purpose of investigating possible band-saw contamination.

It is hoped that the unfortunate experience with xylan highlights the need for extreme vigilance in curating precious extraterrestrial materials, especially where these may be, at some time, analysed for their organic chemistry. Notwithstanding the fact that sample curation is a thankless task, the dangers of complacency in routine procedures cannot be over-emphasized.

References: (1) Wright,I.P., Grady,M.M. and Pillinger,C.T.(1989), *Nature*, **340**, 220-222.