RUST CONTAMINATION FROM WATER LEAKS IN THE COSMIC DUST LAB AND LUNAR AND METEORITE THIN SECTION LABS AT JOHNSON SPACE CENTER. J. J. Kent[1,2], E. L. Berger[1,2], M. D. Fries[2], R. Bastien[2,3], F. M. McCubbin[2], L. Pace[2], K. Righter[2], B. Sutter[2,3], R. A. Zeigler[2], M. Zolensky[2] [1]GeoControl Systems Inc., Jacobs JETS Contract, NASA Johnson Space Center, Mail Code XI2, Houston, TX 77058. [2]NASA Johnson Space Center, Mail Code XI2, Houston, TX 77058 [3]Jacobs, Houston, TX jeremy.j.kent@nasa.gov

Introduction: On the early morning of September 15th, 2016, on the first floor of Building 31 at NASA-Johnson Space Center, the hose from a water chiller ruptured and began spraying water onto the floor. The water had been circulating though old metal pipes, and the leaked water contained rust-colored particulates. The water flooded much of the western wing of the building's ground floor before the leak was stopped, and it left behind a residue of rust across the floor, most notably in the Apollo and Meteorite Thin Section Labs and Sample Preparation Lab. No samples were damaged in the event, and the affected facilities are in the process of remediation.

At the beginning of 2016, a separate leak occurred in the Cosmic Dust Lab, located in the same building. In that lab, a water leak occurred at the bottom of the sink used to clean the lab's tools and containers with ultra-pure water. Over years of use, the ultra-pure water eroded the metal sink piping and leaked water onto the inside of the lab's flow bench. This water also left behind a film of rusty material. The material was cleaned up and the metal piping was replaced with PVC pipe and sealed with Teflon plumber's tape.

Samples of the rust detritus were collected from both incidents. These samples were imaged and analyzed to determine their chemical and mineralogical compositions. The purpose of these analyses is to document the nature of the detritus for future reference in the unlikely event that these materials occur as contaminants in the Cosmic Dust samples or Apollo or Meteorite thin sections.

Methods: Raman spectra were collected using a Horiba LABRAM using a 514 nm excitation laser, a grating of 300 lines/mm, and a 50x objective lens. Laser power was 60 microW total flux with approximate power density of 26 microW/micrometer-squared. Spectra were collected with integration times of 8s per exposure, with three iterations per spectrum. Spectra were collected using Horiba software and analyzed using CrystalSleuth from the RRUFF project (http://rruff.info).

X-ray diffraction analysis were conducted with a Panalytical X'pert Pro powder diffractometer using CoKα source (45kV/40mA). Samples were examined from 4 to 80 2θ with a 0.02° step at 50s/step.

BSE images and EDX data were obtained using the JEOL JSM 7600F scanning electron microscope at NASA-Johnson Space Center. Beam settings of 15kV and 750pA were used for the data collection.

Results: The three analytical techniques used here produced a comprehensive analysis that includes detection of mineral and carbonaceous phases present in the detritus.

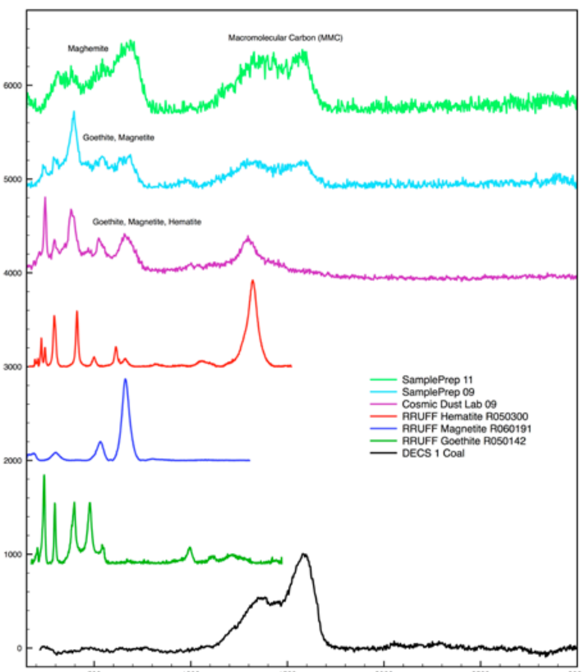

Figure 1: Raman spectroscopy results for Sample Preparation Lab sample analyses. Results show a mixture of iron oxides and carbonaceous species; see text.

Raman Spectroscopy. The Sample Preparation Lab flood detritus is a very fine-grained material dominated by iron oxides/hydroxides with abundant disordered carbon and organic compounds of composition that was indistinct to Raman spectroscopy (Fig. 1). These organic compounds may be bulk organic matter from plant or animal detritus and do not appear as single chemical compounds or simple mixtures. Minor quartz and carbonate also appear. One quarter of the spectra collected (n=25) were obscured by high fluorescence and could not be identified by Raman spectroscopy, which may indicate organic detritus, clay minerals, or amorphous material. Hematite was observed in a single spectrum, and goethite dominated the iron species over magnetite or maghemite with approximate modal abundances of 52, 48, and 12%, respectively. A full 68% of spectra contained poorly ordered carbonaceous material.

The Cosmic Dust Lab materials are dominated by iron oxide/hydroxides (Table 1). Magnetite and hematite predominate, appearing in 85% of the Raman spectra in total (n=26). Goethite is also abundant and appears in 42% of spectra. Single observations of chromite and maghemite were also recorded, with maghemite defined here as a mineral species intermediate between hematite and magnetite without clearly distinct features attributable to either species.

XRD. The XRD data are in good agreement with the Raman results. Detritus sampled from the Cosmic Dust Lab (CDL) only indicated the presence of iron oxide and magnetite, while the samples taken from the Sample Preparation Lab contain a variety of components.

	SPL	CDL
Quartz	54	-
Iron Oxide	24	48
Calcium Carbonate	7	-
Rutile	3	-
Magnesium Silicon Oxide	12	-
Magnetite	-	52

Table 1: XRD-derived modal abundances within rust samples taken from the Sample Preparation Lab and the Cosmic Dust Lab.

SEM. Observations and EDX spectra obtained on the SEM further confirm the Raman and XRD findings (Figs. 2 and 3). Cosmic Dust Lab materials are almost exclusively limited to iron oxides, whereas Sample Preparation Lab material contains a wider variety of detritus.

Discussion: The Sample Preparation Lab material is likely “dirtier” because it is not a clean lab, but rather a wide hallway area leading to the Thin Section Lab areas. There are a series of benchtop saws, grinders, and associated pumps kept in the Sample Preparation Lab area, and the sampling of rusty material was taken from beneath the table these saws, grinders, and pumps reside on. It is probable that particulates from the materials that have been cut and ground using that equipment have fallen under the table over time, and were mixed with the deposited rust particles from the water leak. Consequently, we are primarily concerned about ferric oxides and oxyhydroxide contaminants from both leak incidents.

Although we do not anticipate that these oxide dusts are probable contaminants in the Apollo or Antarctic Meteorite thin sections or the cosmic dust samples, we have documented the mineralogy of these dusts here in case any inexplicable observations of such materials are made from either collection. Moreover, we have archived additional subsamples of the possible contaminants for additional future studies, should they be warrented.

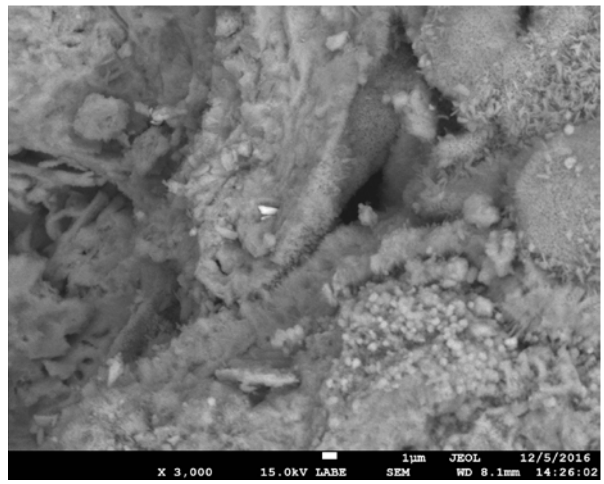

Figure 2: BSE image of rust particles from the Cosmic Dust Lab

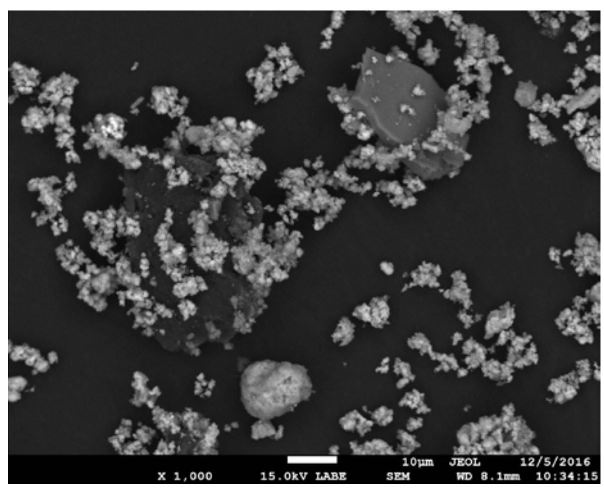

Figure 3: BSE image of rust and other detritus particles from the Sample Preparation Lab