UPDATED STATUS OF THE GENESIS MO-PT FOILS FOR SOLAR WIND RADIONUCLIDE ANALYSIS

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INTRODUCTION: Long-lived radionuclides, ^{10}Be, ^{26}Al, and ^{53}Mn, produced on the surface of the Sun are entrained into the solar wind (SW). Expected fluxes of these nuclides in the SW are <200 atom/cm²/yr at 1 AU, but are highly uncertain. One of the objectives of the Genesis mission was to capture measurable quantities of these radionuclides in large (~8000 cm²) Mo-coated Pt foils deployed in the lid of the sample return capsule (SRC). The Genesis mission exposed these foils to the Sun for ~2.4 yr. Our original plan to analyze the captured SW radionuclides included the following steps:

(1) remove loosely attached terrestrial dust without damaging the Mo coating;
(2) identify and remove micrometeorite (MM) impacts, which contain high levels of cosmogenic ^{10}Be, ^{26}Al, and ^{53}Mn, leaving <1 μg of MM material on the entire foil;
(3) dissolve the Mo layer and separate all SW radionuclides from the Mo;
(4) measure the low concentrations of SW radionuclides by accelerator mass spectrometry (AMS).

Fig. 1. Mo-Pt foil in SRC before launch (a), and after return to Earth and transfer to SSL (b,c). Blue outline in (c) is original size (R~80 cm) of center foil, 50053, before launch.

Main challenges: Upon return to Earth, the SRC crashed in the Utah desert, crushing the foils and contaminating them with Utah dirt and debris from SRC/collector materials [2]. This unexpected crash has presented us several difficult additional challenges, which we have to solve before continuing with step 2-4.

(5) stretching the Mo-Pt foils to near-flat condition;
(6) mapping all contamination by SEM;
(7) reducing oxidized Mo layer to *less reactive* Mo using H_2-reduction.
(8) removing Utah dirt/salt as well as spacecraft debris (collector materials, white paint);
(9) verifying the cleanliness of the foils before dissolving the Mo coating.

Completed challenges:

✓ **Stretching foils (5)**: All of the crumpled Mo-Pt foils have been stretched to their original size (or close to it) using the guitar tuner method (Fig. 2) with minimal damage to the Mo surface.

✓ **Mapping contamination (6)**: All foil pieces were scanned by SEM, in backscattered electron (BSE) mode. BSE images were used to identify surface contamination, delamination of Mo layer (revealing the underlying Pt), and locate impact craters. We determined an average contamination level of ~15 μg/cm² for foil 50053 (~5000 cm²), a factor of ~150 above our upper limit of 0.1 μg/cm² (Fig. 3).

✓ **H_2-reduction (7)**: We developed a H_2 reduction method to convert the MoO_3 layer to a less oxidized form of Mo by exposing the foil for 3-4 weeks in a Parr vessel with a H_2 pressure of 10-30 MPa, at 140 °C (Fig. 4). H_2-treated test foils show much lower Mo losses in cleaning tests compared to the untreated foils.

✓ **Identifying MM impacts (2)**. We expected that ~150 μg of MM material would impact the foil during exposure in space. After scanning SEM images of >3000 cm² of foil, we found only ~20 hypervelocity impacts, ranging in size from 20-120 μm (Fig. 5). No detectable amounts (<10 pg) of MM material were found on the foil !!

Fig. 4. Parr vessel for H_2 reduction

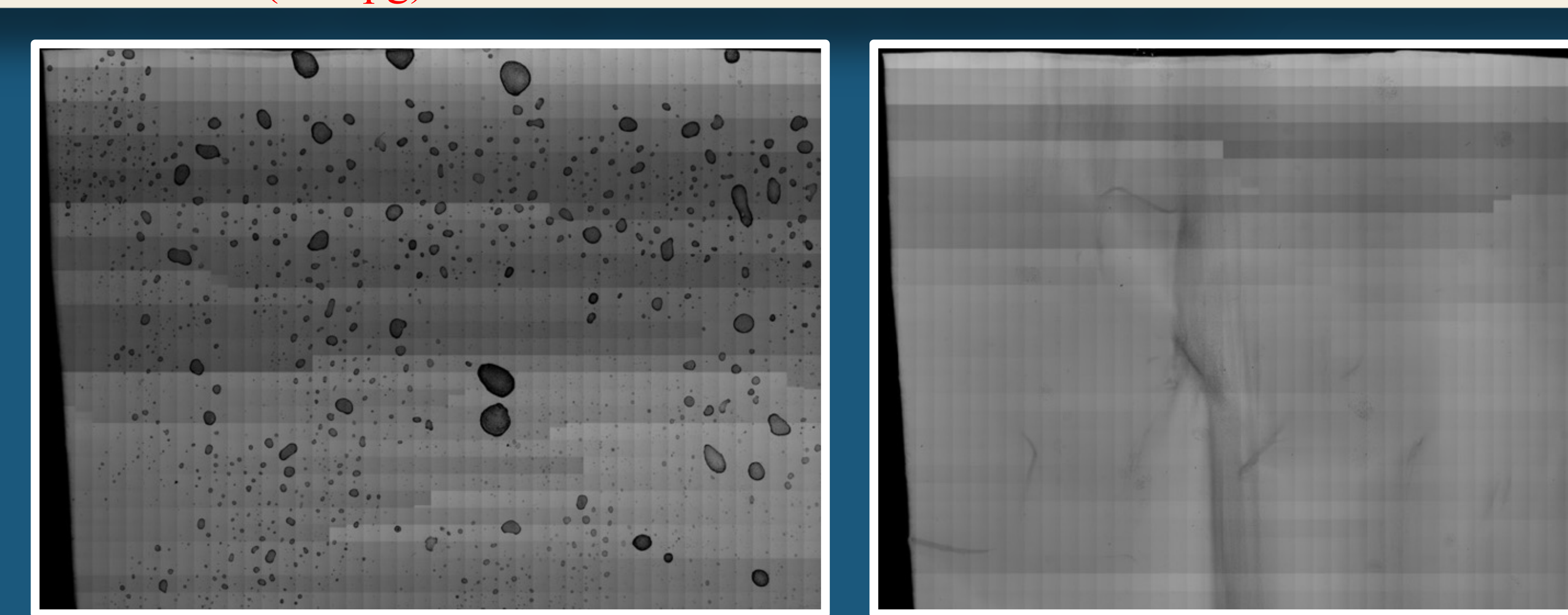

Fig. 6. BSE image of dirty Mo-SS foil (13x7 cm²) before/after cleaning.

Progress on remaining challenges:

- **Removing contamination (8)**: After many tests, mixtures of methanol and glacial acetic/formic acid are most efficient in removing Utah salt/dirt without removing Mo layer. Application of this method on a ~90 cm² Mo-SS foil with ~1 mg of Utah salt/dirt applied (Fig. 6) shows that ~98% of the salt/dirt is removed, while <2 nm of the Mo surface is lost. Similar tests are now being performed on a ~270 g/cm² piece of dirty Mo-Pt flight foil.
- **AMS analysis (4)**. Recent upgrades of the AMS facility at PRIME Lab have lowered the detection limits of ^{10}Be and ^{26}Al by a factor of 2-10, respectively. This higher sensitivity implies that we don't necessarily have to dissolve the entire foil to perform successful SW radionuclide measurements, but can dissolve "only" ~1000 cm².

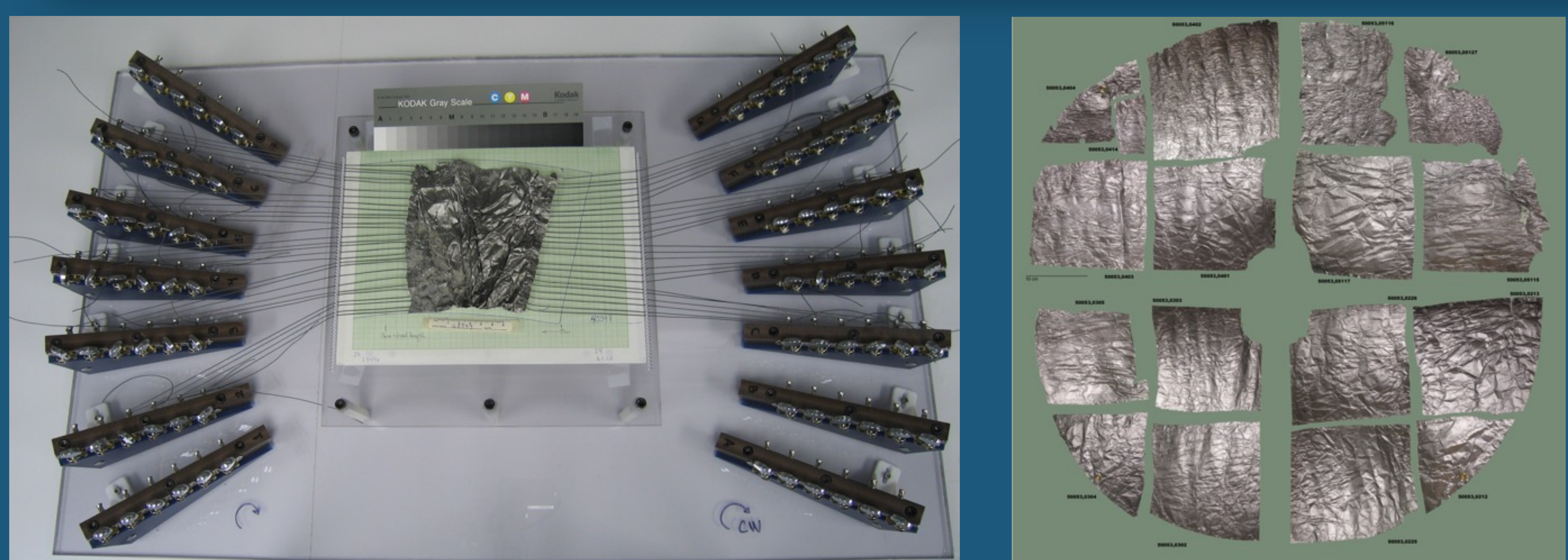

Fig. 2 (a) Expansion of 20x20 cm section of center foil, 50053, using guitar tuner stretching method, (b) shows mosaic of 16 stretched pieces of 50053.

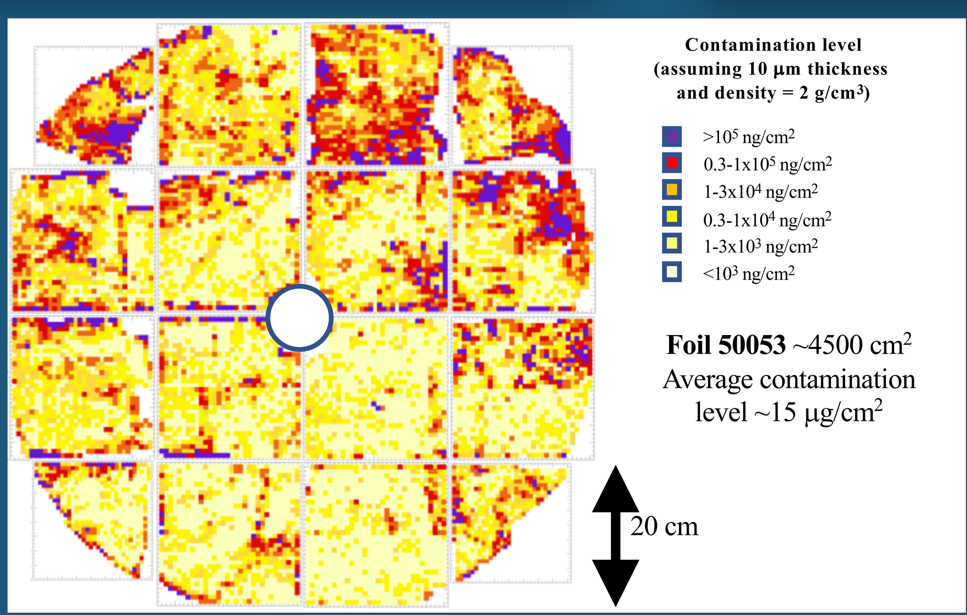

Figure 3. Map of contamination level on foil, 50053.

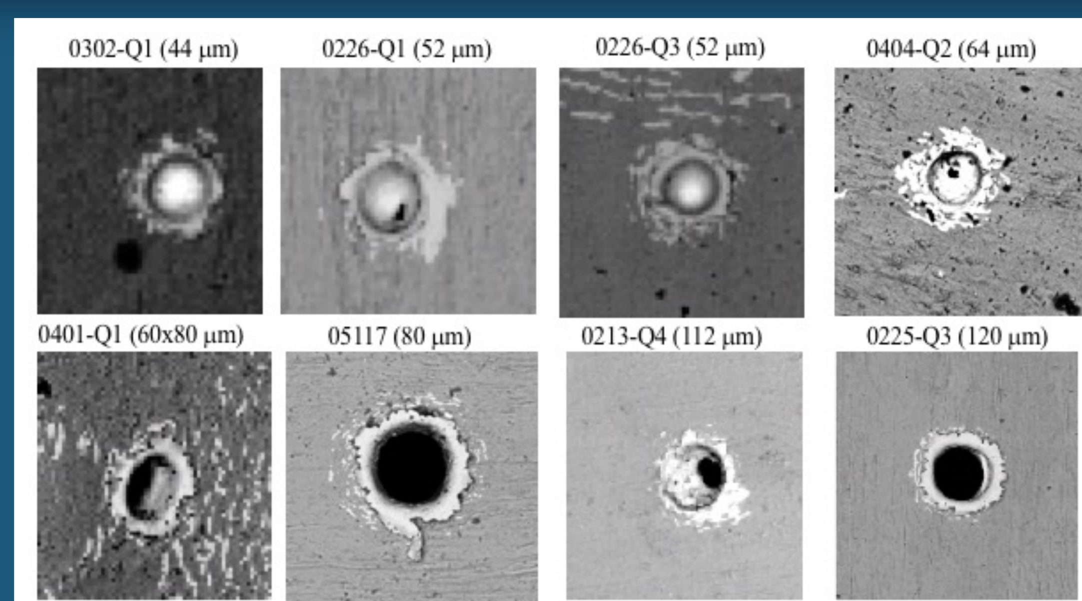

Fig. 5. SEM-BSE images of 8 small impact craters (44-120 μm) on Mo-Pt foil.

CONCLUSION

We have made tremendous progress in development of new techniques to clean the Mo-Pt foils, after stretching them and analyzing surface contamination by SEM. In the next few years we will apply these techniques to several large portions (1000-2000 cm²) of the Genesis Mo-Pt foils to analyze SW radionuclides.

This work was supported by NASA's LARS program. **References:** [1] Jurewicz A. et al. (2003) SSR 105, 535–560. [2] Nishiizumi K. et al. (2005) LPSC XXXVI, #2266.