THE ROLE OF LUNAR SIMULANTS VERSUS APOLLO SAMPLES FOR ISRU ACTIVITIES

Larry Taylor, Earth & Planetary Sciences, University of Tennessee, Knoxville, TN37996; lataylor@utk.edu; and Tranquility Base Inc., Twin Coves Circle, Lenoir City, TN 37772.

The Apollo lunar soils and rocks are a precious national treasure [i.e., they cannot be bought or sold]. Virtually all the studies that have been conducted with these samples have been associated with various aspects of the science of the Moon. Relatively few allocations of lunar samples have been made for engineering/ISRU endeavors. This has necessitated the production of some 25 or different "lunar simulants". Unfortunately the majority of these have been made without the advice of lunar scientists, and are inadequate even for the purposes they were made. To date, there are only two lunar simulants that have received the NASA blessing for doing what they were produced for. Is there a real need for lunar samples for ISRU testing? Let me relate a story about requesting lunar samples for ISRU use (today is my 72 birthday, so you may understand).

Back in the early 80's, the lunar sample committee (then Lunar and Planetary Sample Team – LAPST; now CAPTEM) allocated the first Apollo samples for ISRU work. This was an allocation of 40 g to Dr. T.D. Lin, who worked for Portland Cement and wanted to study the use of lunar soil for making cement on the Moon. It took him almost a year, going back and forth with our committee, of which I was Chair, until we made the allocation to him. Miniaturization is the name of the game. We required him to fully demonstrate that he could use small samples in miniaturized aparatus AND make the required strength, etc. measurements, the same as if he had standard size-sample boxes. This workshop today on mineral liberation and beneficiation is important to our collective understanding of WHY we want various minerals; WHERE to obtain them on the Moon – i.e., rocks versus soils; HOW best to beneficiate them to the grade and yield necessary; and WHAT to use for the terrestrial geologic samples with which to study this ISRU project.

Another story is apropos: Carbotek Inc. in Houston had a patent on the hydrogen reduction of ilmenite to produce oxygen. But, they needed a feedstock that was >90% ilmenite. I undertook a study with Apollo soils and rocks, being a lunatic from Apollo days. When I completed my study of the magnetic beneficiation of lunar soils and mineral liberation of lunar rocks (Taylor and Taylor, this program), I came to the conclusion that I could not meet their requirement by quite a bit. But, I explained that my kinetic experiments with the reduction of ilmenite demonstrated a distinct tendency to produce an aggregated, heavily sintered, waste-product. This would stop up their three-stage fluidized-bed scheme. However, the presence of silicate minerals would help keep this from happening (differences in sintering temperatures). After considerations that a required beneficiation process, as a entirely extra step, was a deterrent to the overall methodology, they decided to go with untreated Hi-Ti mare lunar soil, with minor sizing. The point I make here is that there are different ways to approach an end-point.

There were 382 kg of lunar samples returned by Apollo Missions. The major portion of these in the Lunar Curatorial Vault at JSC, with a contingency batch at White Sands, all stored in dry nitrogen. This total collection consists of a total of 2196 separate samples. Of all this mass of samples, some 80 wt% remains pristine today – i.e., never touched for studied. Why? Frankly I don't know. If we are EVER to return to the Moon for a settlement, ISRU and everything under this umbrella is the most imperative, important, essential, crucial, necessary area of study, not the science area. We know enough about the science of the lunar rocks and soils NOW, in order to satisfactorily prepare for this massive endeavor of returning humans to the Moon.