PROCESSING FROZEN APOLLO SAMPLES IN A NITROGEN ENVIRONMENT.

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Introduction: A few weeks after their return to Earth, several Apollo 17 regolith sample splits and one Apollo 17 basalt were frozen at -20˚C (under dry gaseous N_2 like all other pristine Apollo samples), and have remained essentially unstudied within the Apollo sample collection at NASA's Johnson Space Center (JSC). As part of the Apollo Next Generation Sample Analysis (ANGSA) project, these frozen samples were selected for consortium study in 2019. Although the samples themselves were kept at -20˚C for nearly 50 years, the JSC Curation office has lacked a facility for processing frozen samples under pristine Apollo processing conditions. A temporary lab for this work was designed, built, and tested [1]. Procedures were then developed for working in this unique environment, and the facility was successfully used to process the frozen Apollo samples for scientific allocation.

Lab Design: An Apollo-era glovebox was cleaned and retrofitted to work within a -20˚C environment, installed within a walk-in freezer within the experimental impact laboratory (EIL) at JSC (which itself underwent extensive upgrades and modifications), and plumbed for curation grade gaseous N_2. A clean change room was also installed around the door to the freezer. For technical details on the project, see [1].

Operating Procedures: Cold weather gear was worn, including insulated pants, coat, a hat that covers the ears, and gloves or mittens. The person working inside the cabinet has to wear thinner gloves to allow for adequate fit and dexterity in the cabinet gloves. A clean lab smock, hair net, and nitrile gloves were then worn over the insulated clothing. Because the room was not ventilated, oxygen monitors had to be worn and actively monitored. For safety reasons, work could only proceed for up to 30 minutes at a time, a buddy system in the freezer was required, and a third person would stay outside to also monitor time and oxygen levels. The door opened periodically when leaving the room to exchange some of the air, and the windows on the cabinet had to be wiped down with isopropyl alcohol occasionally to remove frost buildup. Heat sealing couldn't be done inside the cabinet so the Teflon bags were sealed with clips and heat sealed in the anteroom as the samples were transferred out. Otherwise, sample processing was performed according to the same procedures and material limitations as the pristine Apollo sample labs.

Results and Takeaways: The cold environment did not cause any noticeable difference in behavior of the samples during processing compared to working in nitrogen cabinets at room temperature. The biggest difference was the loss of dexterity from wearing insulated gloves inside polyurethane cabinet gloves that are stiff when cold. Wearing face masks turned out to greatly reduce the rate of frost buildup on the cabinet window. After completing the processing of these samples, this cold facility was dismantled, but our experiences here will be used when installing new permanent cold processing facilities in the Building 31 Annex, which should be up and running in a couple of years.

References: [1] Amick et al. (2020) LPSC abstract 1632. *Acknowledgments:* We thank the EIL staff and JSC technicians for their hard work in the physical retrofit of the glovebox, freezer, and change room. We also thank Chris Herd at the University of Alberta for his technical advice in bringing this project to fruition.

Figure 1: *Left:* Working in the cold processing cabinet in cold weather gear. *Top Middle:* Weighing Apollo 17 basalt 71036,0 before processing. *Bottom Middle:* Apollo 17 basalt 71036,0 (left) and ,1 (right) after initial successful chipping. *Top Right:* Apollo 17 regolith sample 76240,6 and the 12 largest rock fragments picked out from it. *Bottom Right:* Curation staff and personnel who helped make this work possible.