**Storage, processing and preparation methods for China's returned lunar samples.** G. L. Zhang[1,2], C. L. Li[1,2], D.W. Liu[1,2], B. Liu[1,2], Q. Zhou[1,2], F. Gao[1,2], H. B. Zhang[1,2], D. Q. Kong[1,2], X. Ren[1,2], [1]National Astronomical Observatory, Chinese Academy of Sciences, 20A Datun Road, Chaoyang District, Beijing , China, 100012, zhanggl@nao.cas.cn. [2]Key Laboratory of Lunar and Deep Space Exploration, National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China.

**Introduction:** From the early 1960s to the mid-1970s, the United States and the former Soviet Union carried out a space race centered on launching several probes and sending people to the moon surface to collect samples [1]. During 1969-1972, six Apollo missions collected 382kg lunar samples at different landing sites on the lunar surface, including rocks, core samples, lunar soil and dust[2,6-10].. Luna 16, Luna 20 and Luna 24 of the Soviet Union also collected about 300g lunar samples from three different locations. In 1979, the United States built the Lunar Sample Laboratory Facility[3,13], the main purpose of which is to provide a pollution-free environment for the preservation of Apollo samples and future lunar samples. Before the samples were distributed to scientists for further scientific research and analysis, the preliminary preparation, test and classification of the samples were completed. The detailed records and catalogue of the lunar samples were formed. The preliminary biological, physical and chemical characteristics of the lunar samples were also obtained. The original samples (those that were not assigned, studied, or displayed), the backup samples, and the samples returned by the researchers were successfully preserved in different locations [2,11-12].

**Mission description:** The third phase of China's lunar exploration project is the unmanned lunar exploration, aiming at returning samples from extraterrestrial objects by the first time. The main tasks of the Ground Research Application System (GRAS) of lunar exploration project include: receiving lunar samples from the Spacecraft system; establishing special facilities and laboratories for sample permanent local storage and backup storage at another place; Preparation and preprocessing of lunar samples.

**Methods:** According to the requirements of the mission, GRAS formed a complete lunar sample preprocessing, storage and preparation plan. This plan mainly includes: handover and transfer of lunar samples from Spacecraft system to GRAS, unsealing of the sample package, sample separation (drilled sample separation and scooped sample separation), sample storage (scooped and drilled samples) and sample preparation. These works will provide important sample information and technical support for the follow-up scientific research.

Firstly, the returned lunar samples will be divided into scooped samples and drilled samples after them entering the lab. Secondly, both scooped and drilled samples will be then divided into four categories: permanent storage samples, backup permanent storage samples, scientific research samples and exhibition samples. Detailed pipeline for this plan is as following:

(1) Handing over and transferring: GRAS receives the sealed package from the spacecraft system. After that, the sealed package will be placed in a transfer box whose inside will be filled and protected by nitrogen. Then, the transfer box is placed in a transport vehicle and transferred to the Lunar Samples Laboratory. After arriving, The sealed package will be taken out from the transfer box and transferred to the room specially designed for Sample Storage and Unblocking.

(2) Unsealing of the sample package: First, the accessories of the sealed package will be removed. Then, the sealed package is sent to the operation cabin of the unsealing glove box (Figure 1) to install the unsealing tool[14]. Second, the sealed package enters the unsealing cabin to open the package and collect released gases (for subsequent gas components analysis). Third, the unsealed package will be is returned to the operation cabin. At this stage, there are another two unsealed containers inside the unsealed package. One is for scooped samples and the other is for drilled sample. We will take out both of these two containers from the unsealed package finally.

(3) Drilled samples division: First, take the soft bag containing drilled samples out of the sealed container, and cut it into several sections of 15cm each. Then, separate the research samples from each section and leave the remaining in the soft bag as permanent storage samples.

(4) Scooped samples division: First, using the unblocking tool specially designed to open the sealed container and then collect the samples into a squared container. Then, and using the geologically commonly used 16 equal division method for sampling. After this process, the scooped samples will be divided into research samples, permanent storage and backup permanent storage samples. All these samples will be placed into the corresponding sample boxes.

**Results:** After division of the drilled and scooped samples, The permanent storage samples will be transferred to the permanent storage glove box in the long-term storage room, and the research and backup permanent samples will be transferred to the temporary glove box (Figure 2) waiting for further utilization[4,14].

For samples preparation, single-particle samples selection(collect crystallized minerals and different glass): We will transfer the research samples from the temporary storage glove boxes to the glove box with a inside and filled with pure nitrogen. Then, facilitated with the stereo microscope, we will select the required single-particle samples including minerals/glass particles, and lithic fragments.

Samples preparation for structure and composition analysis: We will separate appropriate amount of samples for research from the unsealing glove box, transfer it to the room specially for preparation and to make thin section of samples.

All the tools that contact with lunar sample are made of stainless steel, teflon, quartz glass or materials of known composition to strictly control the factors that will affect subsequent scientific analysis. The water and oxygen content in the glove box (filled with pure oxygen) will be strictly monitored to prevent the lunar samples from earth pollution.

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Figure 1: Unblocking grove box

Figure 2: Lunar sample storage grove box

**References:** [1]Allen C.et al. (2011) Chemie der Erde Geochemistry, 71, 1-20. [2] Allton J.H. (1989) In National Aeronautics and Space Administration, 3-87.

[3] Lunar Science Institute (1972) in Lunar Science Institute publish, 1-94. [4] Lv S. Z. et al. (2017) Chinese Journal of Vacuum Science and Technology, 37(8).[5] NASA Manned Spacecraft Center. (1969) Washington DC: U. S. Government Printing Office, 1-204.[6] NASA Manned Spacecraft Center. (1970) Washington DC: U. S. Government Printing Office, 1-227.[7] NASA Manned Spacecraft Center. (1971) Washington DC: U. S. Government Printing Office, 1-309.[8] NASA Manned Spacecraft Center. (1972a) Washington DC: U. S. Government Printing Office, 1-534.[9] NASA Manned Spacecraft Center. (1972b) Washington DC: U. S. Government Printing Office, 1-614.[10] NASA Manned Spacecraft Center. (1973) Washington DC: U. S. Government Printing Office, 1-644.[11] Neal C.R. (2009) Chemie der Erde Geochemistry, 69: 3-43.[12] Shearer C.K. & Borg L.E., (2006) Chemie der Erde Geochemistry, 66: 163-185.[13] Sun L. Z. et al. (2012) Earth Science Frontiers, 19(6):128-136.[14] Wu Q.P. et al. (2017) Chinese Journal of Vacuum Science and Technology, 37(9): 851-856.