NEW CONCEPT OF SAMPLING THIN ATMOSPHERES OF PLANETARY BODIES FOR RETURN MISSIONS. A. Meshik and O. Pravdvtseva, McDonnell Center for Space Sciences and Physics Department at Washington University, Saint Louis, MO 63130 (ameshik@physics.wustl.edu, olga@physics.wustl.edu).

Introduction: Elemental and isotopic compositions of planetary atmospheres provide valuable information about early evolution of planets, their geological activities, and catastrophic events occurred in the past.

Our laboratory was founded by Charles Hohenberg more than 4 decades ago [1] and half of this time we have been involved in the Genesis NASA mission [2]. Our efforts resulted in precise isotopic compositions of the solar noble gases [3, 4]. These compositions are believed to represent starting material of the Solar System and most likely the composition of protoplanetary disc from which the Sun has been formed.

The "hard" landing of the Genesis return capsule caused significant contamination of solar wind collectors. After years of trials and errors we developed and refined a stepped UV-laser extraction technique which allowed us to extract implanted solar wind "layer-by-layer", effectively separating surface contamination. An example of how this technique has been applied for Ar depth profiling of the polished aluminum solar wind collector is shown in Figure 1.

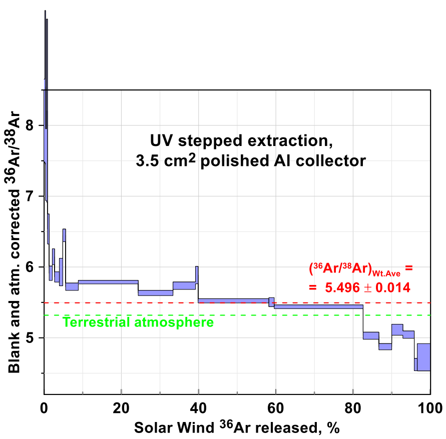

Fig. 1. Depth profile solar wind argon released from Genesis Al-collector shows that the heavier isotope is implanted deeper because the implantation occurred at constant velocity. The weighted average of all extraction steps remains the most precise composition of solar wind Ar to date. Terrestrial atmospheric Ar is depleted in light isotope supporting the partial loss of atmosphere likely during moon forming event.

Here we suggest using this technique, which worked nicely for the Genesis mission, to study volatiles from small planetary bodies. These volatiles can be efficiently captured by portable ion pumps, ion-getter pumps or orbitron pumps which will ionize the ambient gas, implant it into the pump cathode, and bury by sputtering titanium. After return to the Earth the pumps will be disassembled and the cathodes will be processed the same way as our Genesis solar wind collectors. The implantation depths will depend on the operation voltage of the pump, which is typically 7 kV, resulting in energy similar to that of solar wind He (4 keV) and Ne (20 keV).

An ion pump can be miniaturized to meet payload requirements. The orbitron pumps can be scaled down to the size of microchip [5]. This opens the opportunity to bring multiple samples from the planetary atmospheres taken from different altitudes back to the Earth.

This concept can be tried first with high-elevation balloons and/or rockets to study the uppermost terrestrial atmosphere. We may be able to answer the long-standing question about "missing" terrestrial xenon. The search for potential Xe traps (ices, sediments, shales, clathrates...) turned out to be negative. Now only two possibilities remain: (1) the deep Earth interior where pressure and temperature are apparently favorable for Xe to form chemical compounds [6] and (2) because of the lowest (among the noble gases) ionization potential, xenon is photo-ionized in the upper atmosphere and escapes it [7]. The noble gas composition in the thin upper atmosphere can be the key to the "missing xenon paradox".

The Hayabusa mission attempted to capture the asteroidal volatiles, but the capture was not efficient. Our concept could work there since the ion pump would both concentrate and protect the captured volatiles from the later terrestrial exposure.

We realize that many technical problems should be addressed before the concept proposed here becomes feasible. We hope that the successful experience of bringing Solar Wind back to the Earth for precise isotopic analyses can be used for analyses of some planetary volatiles, including the gases in uppermost part of our own terrestrial atmosphere.

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