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STRATOSPHERIC DUST COLLECTIONS: VALUABLE RESOURCES FOR SPACE AND ATMOSPHERIC SCIENTISTS; Ian D. R. Mackinnon, Department of Geology, University of New Mexico, Albuquerque, NM 87131.

Collections of solid particles from the Earths' stratosphere have been a significant part of atmospheric research programs since 1965 [1], but it has only been in the past decade that space-related disciplines have provided the impetus for a continued interest in these collections. Early research on specific particle types collected from the stratosphere established that interplanetary dust particles (IDP's) can be collected efficiently and in reasonable abundance using flat-plate collectors [2-4]. The tenacity of Brownlee and co-workers in this subfield of cosmochemistry has led to the establishment of a successful IDP collection and analysis program (using flat-plate collectors on high-flying aircraft) based on samples available for distribution from Johnson Space Center [5]. Other stratospheric collections are made, but the program at JSC offers a unique opportunity to study well-documented, individual particles (or groups of particles) from a wide variety of sources [6]. The nature of the collection and curation process, as well as the timeliness of some sampling periods [7], ensures that all data obtained from stratospheric particles is a valuable resource for scientists from a wide range of disciplines. A few examples of the uses of these stratospheric dust collections are outlined below.

A number of attempts have been made at a taxonomy for stratospheric particles [6,8], including those of extraterrestrial origin [9]. The most recent classification scheme for all stratospheric particles [10] appears to provide a simple and reliable method for their documentation. A useful classification scheme is an essential element of any broadly-based data set as it allows communication between different disciplines (e.g. orbital debris vs. atmospheric dynamics). In addition, new materials entering the stratosphere may be readily identified. Thus, as additional fine-grained ($<100\mu m$) material from orbiting spacecraft (satellites, shuttles or a space station) enter the Earths' atmosphere, a frame of reference is available from current stratospheric particle collections and classification. This frame of reference will become quite important for cosmochemists interested in the collection of "exotic" IDP's such as high-temperature condensates [e.g., 11].

An understanding of global parameters at a particular point in time in the stratosphere can also be obtained from a study of complete collection surfaces. For example, an accurate assessment of particle concentration over a wide range of sizes was experimentally determined for the stratospheric cloud formed one month after the eruption of El Chichon [7]. Additional studies on the El Chichon cloud over a six-month period showed that volcanic ash settles out of the stratosphere at a rate determined primarily by particle shape and density [12]. Another study during a volcanically quiescent period [13], has shown that total particle number density during the Summer of 1981 was $\sim 2.7 \times 10^{-1}$ cm^{-3}, for particles $>1\mu m$ diameter. However, $>95\%$ of these particles were $<5\mu m$ diameter. With the above classification scheme, an estimate of micrometeorite number density at $\sim 20km$ altitude can also be made. The estimate for Summer, 1981 is 5×10^{-2} cm^{-3} for particles $>1\mu m$ diameter. This micrometeorite number density is comparable to predicted concentrations of orbital debris of similar size range for the latter part of this decade [14]. However, under current ambient conditions, number density and particle collision calculations indicate that the probability of IDP contamination by solid anthropogenic particles in the stratosphere is negligible [13]. Continuation of these types of studies, for shorter collection periods at regular intervals, can provide important experimental data on the contributions of orbital debris, rocket firings and transient events (e.g. volcanic eruptions, nuclear explosions) on the total stratospheric particle budget.

Sophisticated analyses of individual particles collected from the stratosphere have already provided a wealth of data on IDP's [15-17]. A more recent study on known terrestrial particles (e.g. Al_2O_3 spheres from solid rocket exhausts) has shown that large (10μm diameter) spheres reside in the stratosphere for a time long enough to react with ambient sulfate aerosols [18]. This observation provides atmospheric scientists an experimental boundary condition for sulfate aerosol reactivities with specific substrates. Further work of this type may allow estimates of in situ aerosol reactivity over a range of particle types, or, conversely, estimates of particle residence time at specific altitudes.

The collection and curation of all stratospheric particles through the JSC Curatorial Facility has provided new insight into the nature of natural and man-made particles which occur at ∿20km altitude as well as the fine-grained extraterrestrial materials intensively studied by scientists in the NASA Planetary Materials Program. With time and imagination, this valuable resource can provide a significant increase in our understanding of the lower stratosphere and an excellent platform from which to train and develop younger scientists interested in the synergy of the Earth/Low-Earth-Orbit environment.

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