THE PALI AIKE WINDSTREAK FIELD, SOUTHERN PATAGONIA, ARGENTINA  


Introduction: Windstreaks are amongst the most recent and abundant aeolian features on Mars; effects are visible at scales from micrometers to tens of kilometers. In general, wind streak genesis involves three modes of sediment transport—saltation, traction, and suspension—and a range of particle sizes from clay to granules [1]. Thomas et al. [2] classified the range and variety of Martian windstreaks into those attributed to: (a) removal of fines in the lee of an obstacle, (b) erosion of material everywhere except in an obstacle’s lee, and (c) deflation of a material and deposition downwind of the source. This last type of windstreak, which comprise the main focus of our work, are particularly well-expressed in western Arabia Terra [e.g. 2,3,4], where they are interpreted to consist of relatively thin (< 1 m) deposits of silt-sized sediments deflated from from barchan dune fields located within impact craters [1]. Based on analyses of Viking data, Thomas et al. [5] show that approximately ¼ of impact craters (> 20 km) at high latitudes typically contain dune fields that form the source regions of windstreaks. Mars Odyssey (MOY) Thermal Emission Imaging System (THEMIS (the IR subsystem has a resolution of 100m/pixel, and the VIS subsystem 19m/pixel [6])) day and night calibrated Band 9 radiance images [7] reveal that intra-crater dune fields consist of coarser particle sizes than windstreak materials, which is consistent with sustained deflation of the finer-sized particles from the dune fields to feed the windstreaks. Thermal emissivity data from MGS Thermal Emission Spectrometer (TES) [8,9] (resolution 3 km) reveals that intra-crater barchan dune fields in Western Arabia Terra consist of largely ST1, interpreted as unweathered basalts [8,9], and that windstreaks consist of ST2, interpreted as andesite [9], oxidized crystalline basalt, or partly weathered basalt [10]. Salts have been identified as key components in aeolian deposits, for example in modern and lithified dunes studied by the Mars Exploration Rover Opportunity [11] and the part of the northern circumpolar erg, which has been found by analysis of Mars Express OMEGA data [12] to contain abundant gypsum. It is unclear whether salts are key dune-forming grains in those regions or consist of interstitial cements [13].

Pali Aike Windstreaks: We have identified a zone of windstreak occurrence within the Pali Aike Volcanic Field, which is located in the southern Patagonia plateau, in the Argentinean province of Santa Cruz, approximately 60 km west of the far southern City of Rio Gallegos (Fig.1).

1 Recent and on-going geologic investigations using THEMIS, MOC, and MGS Mars Orbiter Laser Altimeter (MOLA) data also reveal that between 65 N and 90 S there are 661 impact craters that contain dune fields, of which 169 are < 20 km in diameter [R. Hayward, USGS, pers. com.].
samples show that the playa is mostly composed of a playa crater (Fig.1). Preliminary analysis of collected windstreaks have different compositions and granular properties. We have carried out field-based observations that show that a zone of dust haze extended from the end tip of one of the windstreaks that has advanced since 2000 (Fig. 2). This indicates that this particular windstreak may be presently actively propagating and that it may in fact serve as an important sedimentary source to a playa crater approximately two kilometers downwind from the windstreak and from which another windstreak sources and extends further east (Fig. 1). Thus this region comprises a superb site to investigate the mechanisms involved in the propagation and stabilization of windstreaks, as well as the interplay between windstreaks and intra-crater sedimentary deposits.

Figure 2. Haze over the downwind end of the windstreak. A. View from west of the windstreak (viewing position is indicated in top right inset). B. View east of the windstreak from within the eastern margin of the playa crater.

2) On Mars, not all impact craters that contain dune fields within a certain region, form the source regions of windstreaks. In the region of study, windstreaks form in association with some playas, but do not form in association with volcanic cones that contain significant deposits of sand-sized particles.

3) Fixation of sedimentary particles through cementation into duricrust [14] in the Martian intercrater plains is consistent with the fact windstreaks produced by intra-crater dune field deflation do not appear to be associated with similar deposits produced by the mobilization of inter-crater plains materials. In the region of study the intercrater plains are densely vegetated, and therefore, just like in the Martian plains, do not form a likely source of sedimentary particles to the windstreaks.

4) A large number of Martian windstreaks have very high length-width ratios, appear to propagate over long distances and over topographically irregular terrains. A surveyed windstreak consists of a sandsheet approximately 10 km long and 2 km wide and has distinct, well-defined margins. Notice how the course of windstreak propagation does not appear to have been affected by topographic obstacles (long white arrow in Fig.3).

5) On Mars, the intra-crater dune fields and associated windstreaks have different compositions and granular properties. We have carried out field-based observations and samples’ collection at a windstreak and a playa crater (Fig.1). Preliminary analysis of collected samples show that the playa is mostly composed of dolomite mud clasts that are poorly sorted and angular with sharp edges, suggesting that the grains were directly derived from semi-indurated mud probably by desiccation. On the other hand, the windstreaks contain significant amount of sorted and sub-round quartz with minor-subordinate amount of dolomite indicating wind-driven erosion and abrasion. Indurating salts may derive from sea salts, regional groundwater flow from the Andes, local groundwater, or surface weathering of rocks exposed within the craters.

Figure 3.A. Looking east from the midsection of the windstreak. Notice how the windstreak tapers towards its end. The white dot shows the location of panel C. B. Looking west from the midsection of the windstreak. Notice the high length-width aspect ratio in this section of the windstreak. The white box shows the location of panel D. Small white arrows in panels a and b show the location of the same dune. C. Close up of a margin of the windstreak (location in A, viewing direction to the west). Notice how the windstreak has notoriously distinct margins and a rippled surface. D. Close up of section of the windstreak shown in panel B. Notice how here too, the windstreak has well-defined margins.