CONSTRAINTS ON THE GEOLOGIC AND AQUEOUS HISTORY OF THE NORTH POLAR REGION OF MARS FROM THE MINERALOGY OF NORTH POLAR SEDIMENTS. B. Horgan[1] and F. Seelos[2], [1]Department of Earth, Atmospheric, and Planetary Sciences, Purdue University, West Lafayette, IN (briony@purdue.edu), [2]JHU/Applied Physics Laboratory, Laurel, MD.

Introduction: The origin and timing of deposition of the ice-rich layers of the martian north polar plateau, Planum Boreum, are of interest to the Mars community because they may provide constraints on Mars's recent climate history [1]. However, the deposits within and around Planum Boreum also record a diverse history of sedimentary and aqueous processes that likely reflect those that have been ongoing throughout the northern lowlands since the Hesperian [2-9]. In this study, we show that the north polar surface sediments of diverse mineralogies are directly sourced from specific layers within Planum Boreum, and that these mineralogies also correspond to more extensive units within the northern lowlands. Thus, we hypothesize that the north polar sediments were originally sourced from these larger units, and emplaced within Planum Boreum via impact and aeolian processes. We can therefore use these relationships to place constraints on the age and origin of both north polar and northern lowlands units, including the north polar layered deposits (NPLD).

Data Sets: We have used near-infrared spectra (~0.3-2.5 μm) from the Mars Express OMEGA and MRO CRISM imaging spectrometers. Initial interpretations were completed using calibrated summer OMEGA observations mosaicked into a 1 km/pxl polar stereographic mosaic above 70°N [9]. We are also constructing a new ~200 m/pxl CRISM multispectral mosaic [7] above 75°N with enhanced calibration techniques to investigate terrains near scarps and troughs that are compromised in OMEGA observations by mixing with plateau ice and slope-related phase effects. Finally, we are conducting a detailed investigation of Planum Boreum scarps with full-resolution (18 m/pixel) CRISM enhanced MTRDR products [10].

Mineral detection methods: Hydrated minerals are mapped using the 1.9 μm band depth, modified to account for the presence of ice [6]. Water ice is mapped using the 1.5 μm band depth [4]. Iron-bearing minerals are detected based on the position and shape of the ~1 μm iron absorption band. Band position alone can be used to broadly differentiate minerals: iron oxides and low-Ca pyroxene (LCP) usually exhibit band centers between 0.88-0.94 μm, high-Ca pyroxene (HCP) 1.00-1.05 μm, olivine 1.04-1.09 μm, and iron-bearing glass 1.10-1.18 μm [11]. When these minerals mix, the band centers and shapes vary in predictable ways, and thus these parameters can be used to identify even relatively small abundances of most Fe-minerals and glass in mixtures [12].

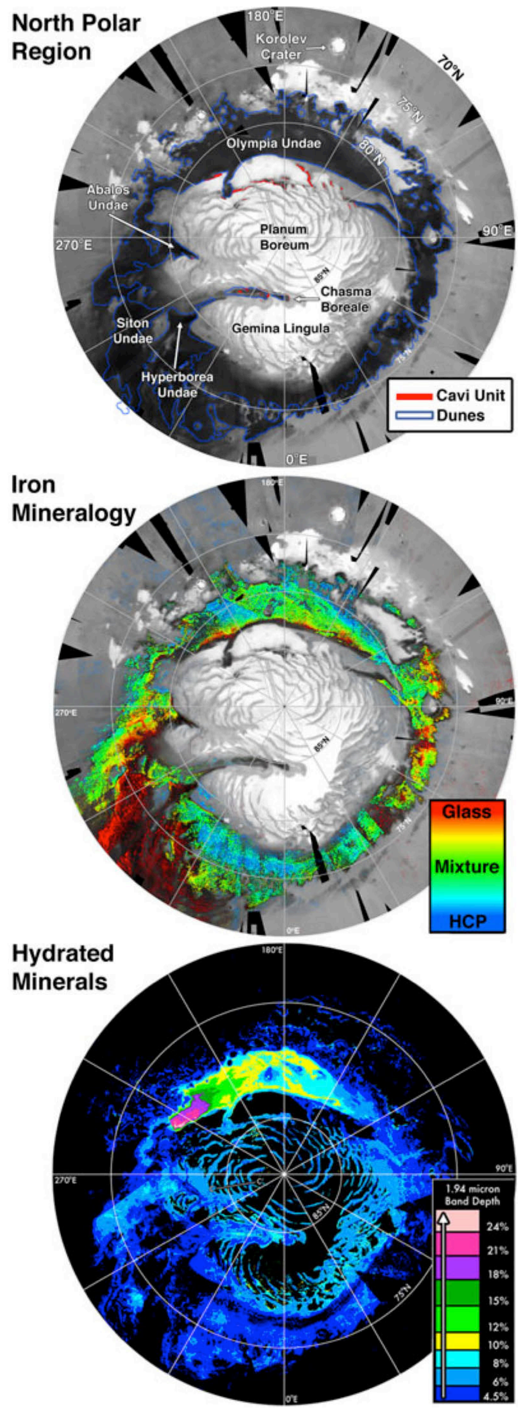

***Figure 1:** OMEGA maps of north polar region. Top: major features on 1 μm albedo. Middle: Iron mineralogy derived from 1 μm band center. Bottom: 1.9 μm hydration band depth, mostly indicating gypsum.*

Mineralogy of north polar sediments: Based on our low-resolution OMEGA map, we have identified three major spectral endmembers in dark north polar sediments. *(1) Gypsum*: strong hydration band and other diagnostic gypsum signatures throughout the Olympia Undae dune field [4], as well as weaker signatures on Planum Boreum [6,13] associated with the north polar veneers [14]. *(2) HCP:* strong 1.01 and 2.10 μm iron bands in western Olympia Undae and weaker signatures on and near Planum Boreum associated with the veneers. *(3) Weathered iron-bearing glass:* weak 1.10-1.15 μm iron bands and a concave up spectral slope from 0.7-1.5 μm consistent with weathered glass in dune fields 260-300°N, far eastern Olympia Undae, and many of the north polar chasmata [9].

Age of altered lowlands surface sediments: Sources of weathered glass-rich sediment in the north polar region are highly correlated with exposures of the Planum Boreum cavi unit, an ancient ice-indurated dune field that comprises up to 1.5 km of the Planum Boreum basal unit [15]. Similar weathered glassy surficial deposits cover much of Acidalia and Utopia Planitia [9], so we hypothesize that the cavi unit sediments were created via deflation and aeolian transport of these plains units. Interestingly, this places an upper limit on the age of the widespread northern plains glass. The Rupes unit, which underlies the cavi unit, is dated to the Late Hesperian or Early Amazonian [5]. This implies that deflation of the glassy plains sediments, as well as most likely original emplacement and alteration, occurred during or after this time period.

Age of the NPLD: The north polar veneers are the sediments that drape Planum Boreum, and emanate from the Planum Boreum 2 unit [14], a sedimentary unit located between the upper and lower NPLD. It has been proposed that these sediments are a dusty sublimation lag [15]; however, this is inconsistent with their dominantly HCP mineralogy. An aeolian origin is also unlikely on top of the plateau. We propose that these sediments may instead be a layer of impact ejecta. Regardless of their origin, the presence of this layer above the bulk of the NPLD may have protected the NPLD from sublimation during periods of high obliquity. Current models suggest that the NPLD could not have survived the most recent obliquity event 5 million years ago [16], but if these insulating sediments were present at that time, the NPLD could be much older.

CRISM hi-res analysis: Preliminary analysis of CRISM MTRDR observations over the Chasma Boreale scarp appears to generally support the inferences made from the lower resolution OMEGA map. The cavi unit exhibits spectral signatures similar to that of the OMEGA weathered glass unit, and the north polar veneers exhibit HCP-like signatures. Interestingly, the strongest hydration signatures at this location are associated with sediments on the chasma floor, potentially sourced from the cavi unit. More detailed analysis with methods like those used on the OMEGA map will help to confirm the hypotheses discussed above.

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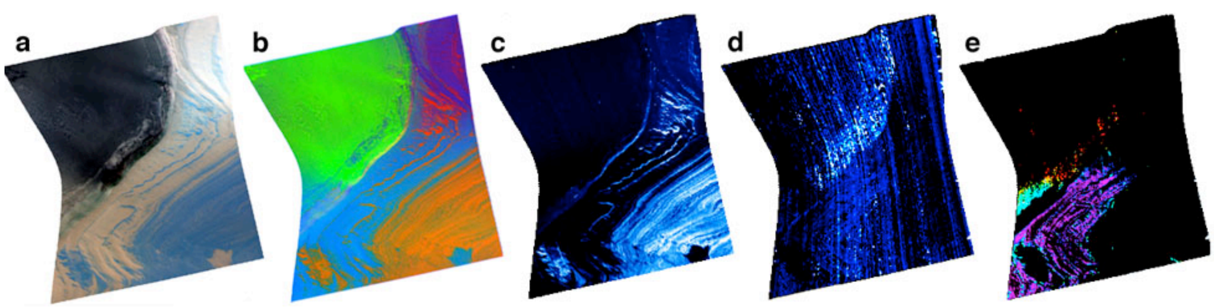

Figure 2: *CRISM FRT0000C093 at the head scarp of Chasma Boreale, with the plateau to the bottom right and floor to the upper left, separated by an exposure of the lower PLD and the cavi unit. (a-b) False color RGB composites of VNIR and IR parameters (a: 2.5/1.3/0.77μm; b: BD1500/BDI1000VIS/RBR), only possible with joined MTRDR data [10]. (c) 1.5 μm ice band depth [6] showing ice on plateau. (d) 1.9 μm band depth (corrected for ice), indicating hydrated minerals on chasma floor. (e) Concavity [9], low values (purple/blue) indicate pyroxene on the plateau, high values (green/red) indicate weathered glass in the cavi unit.*