MER EARLY TRAVERSE MAPPING: MOC VS HIRISE LOCALIZATION. Philip J. Stooke[1], [1] Centre for Planetary Science and Exploration, and Department of Geography, University of Western Ontario, London, Ontario, Canada N6A5C2, pjstooke@uwo.ca, http://publish.uwo.ca/~pjstooke.

Introduction: The Mars Exploration Rovers Spirit and Opportunity landed on Mars in January 2004 and operated for seven and nine Earth years respectively (Opportunity is still functioning productively). Site certification and traverse planning were originally based on Mars Global Surveyor MOC images with resolutions of up to 1.5 m/pixel. Mars Reconnaissance Orbiter arrived at Mars in 2006 and obtained its first images of the rovers on 3 October (Opportunity) and 22 November (Spirit). Since then all traverse planning has made use of HiRISE images with resolutions of about 25 cm/pixel. Now it is possible to revisit the early mission localization results for both rovers and to assess their accuracy. Results suggest that both rovers were typically located within about 15 to 20 m of their true positions but errors of as much as 50 m occur. Comparisons with the PDS Mosaic Viewer map show errors usually smaller than 10 m but occasionally up to 20 m.

Method. The data used for this study are the contemporary route maps released through the MER website at JPL, a new set of route maps compiled by the author on HiRISE bases, and surface panoramas (360 degrees where possible, partial if full data were not obtained), most of which are available through PDS. The panoramas were converted to a polar format and modified from a simple polar projection by enlarging the radial scale as a function of elevation, giving in effect a map of the site extending out to the horizon (Figure 1). The inner part of the projection approximates a map, the outer part is vertically exaggerated, making distant features more recognizable than a standard polar projection. Features in these circular projections were matched to HiRISE images to identify rover locations to within about 1 m (estimated by comparing with later MER route mapping by Tim Parker of JPL, also posted on the MER site). The new set of route maps was compiled by locating each end of drive location and adding the route itself between stops from images of the tracks in panoramas and in HiRISE images where visible. The JPL route map and the new route map were compared by overlaying the two, aligned by matching the larger terrain features. Also the more recent maps available through the NASA PDS Analysts Notebook Mosaic Viewer were registered and superimposed for an additional comparison.

Spirit traverse. The first image of Spirit from HiRISE was taken on Spirit sol 1026 while it was at Low Ridge Haven just after the second winter. Earlier route planning was based on MOC images during the long trek from the landing site to the Columbia Hills and at West Spur, Husband Hill and Home Plate. Direct comparisons of locations (Figure 2) show that the mapped traverse was usually close to the actual traverse (typically within 10 m), but that location errors along the route were larger, rising to 40 m in places (Figure 3). HiRISE images of tracks confirm the comparisons. Particularly bad locations include sols 122, 123 and sols 143-154. Sources of error include high sun angles in some MOC images (varying with season), limited azimuthal coverage of surface panoramas and relatively featureless terrain in some areas.

Opportunity traverse. The first image of Opportunity from HiRISE was taken on Opportunity sol 957 while it was at Cape Verde on the edge of Victoria crater. Before that time route planning was based on MOC images during the drive from the landing site to Endurance, to Erebus and finally to Victoria. Opportunity maps at JPL are inferior to Spirit's, with less detail and infrequent sol labels. Traverse accuracy was similar to Spirit's (typically within 10 m), but location errors along the traverse were larger, rising to 50 m in places. Particularly bad locations include sols 410-413. MOC images of Meridiani show fewer features than those at Gusev but route accuracy was maintained as the 'crater-hopping' design of the traverse allowed frequent location checks. Again the rover tracks seen in HiRISE images as far back as the rim of Endurance crater help confirm the true locations.

The PDS maps are usually better than the original mission maps, but the route is often simplified and some stops are omitted altogether. Errors on the order of 10 m are common, probably related to registration of raw position data with the HiRISE image base, but errors on the order of 50 m can occur, for example at Opportunity sols 410-413.

Comments. Full Navcam panoramas are invaluable for accurate location and route mapping. Monoscopic or 2x downsampled images would be acceptable if downlink is limited. Rearward imaging of tracks along the route is desirable for route reconstruction. This comparison pointed out the lack of an official, detailed rover route map with an accurate traverse, labelled with stops, dates and feature and target names, which is highly desirable after the mission for accurate location of observations. Mission cartographic products should be part of the PDS Analysts Notebook submission.

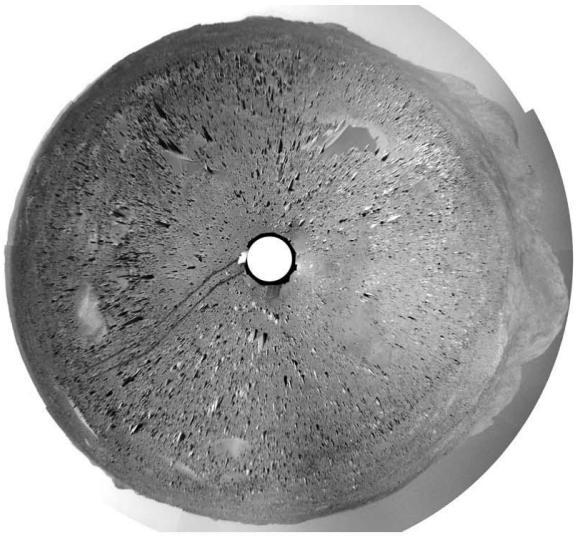

Figure 1. Circular projection of Spirit Navcam panorama from sol 144.

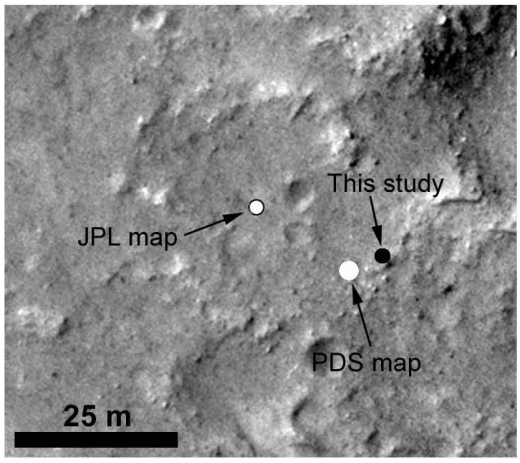

Figure 2. Sol 144 location as mapped in this study, on the JPL MER website, and on the PDS Mosaic Viewer map. Background: HiRISE.

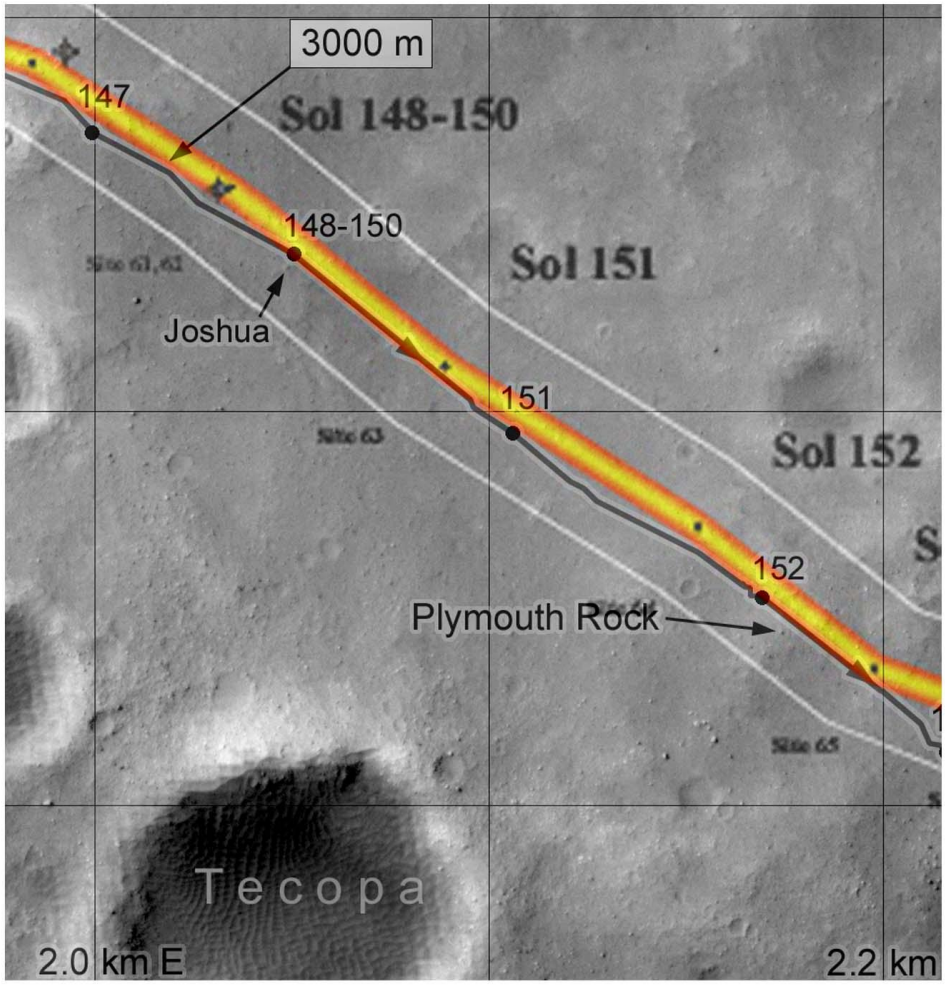

Figure 3. Comparison of Spirit route maps - this study (black line, large dots) and the JPL MER website route map (yellow line, small dots). Position errors are 5 to 10 m across the track, about 25 m along the track, the JPL map lagging the true position..