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Magnetic anomaly mapping on the Martian surface with the SVM method

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Although Mars has no global magnetic field of the core dynamo origin at present, strong magnetic anomalies of the crustal origin have been detected by the satellite observation (Acuña et al., 1998). All of the Martian magnetic fields mapped so far were normalized at relatively high altitudes, 400 km using magnetometer data (Acuña et al., 2001; Connerney et al., 2005), and 185 km by electronreflectometer data (Lillis et al., 2008). These magnetic anomalies often show systematic patterns such as magnetic stripes. Connerney et al. (2005) reported several lineated magnetic anomalies of ∼25-degree wavelength in the Meridiani region, suggesting possible existence of plate tectonics in the early Mars. As described above, magnetic anomalies may have information about tectonic processes of the ancient Mars associated with magnetization acquisition. Thus it is important for understanding the Martian evolution to compare the Martian magnetic anomalies with surface features, that is, topography, geology and so on. Regarding the comparison purpose, the previous maps normalized at high altitudes are inappropriate due to poor spatial resolution. The magnetic field observed by a satellite at a 400 km altitude is effectively a convolution of the neighboring crustal magnetic fields within ∼800 km in diameter (∼13 degrees on Mars). In addition, it is difficult to detect fine structures of the crustal magnetic fields at high altitudes due to rapid attenuation of short wavelength components with respect to altitude. To overcome such difficulties we have applied the surface vector mapping (SVM) method, which is originally developed to map the lunar magnetic anomalies at the surface (Tsunakawa et al., 2014), to those of Mars. To check applicability, the regional SVM method has been tested for the Terra Sirenum region in the southern hemisphere. Based on the radial components at the surface inferred by the SVM method, we reproduce the magnetic fields at 200 km altitude to show good consistency with the previous maps (Purucker et al., 2000). The SVM map of radial components shows elongated magnetic anomalies of ∼3-degree wavelength which is much shorter than that in the previous map (Connerney et al., 2005). We also apply the regional SVM method to the Meridiani Planum near the equator, where plate tectonics was suggested by Connerney et al. (2005). Although a few elongated magnetic anomalies are detected on the SVM map, the overall patterns of magnetic anomalies are so complicated that it seems difficult to find something to support the Martian plate tectonics.

Keywords: Mars, magnetic anomaly, Martian surface