



Multifrequency polarimetric ALOS PALSAR and RADARSAT-2 analysis over the archaeological area of Djebel Barkal (Sudan)

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Differences in vegetation growth and in soil moisture content generate ground anomalies which can be linked to the presence of subsurface anthropic structures. Such evidences have been studied and observed for a long time by means of aerial photographs, thanks to planned campaigns or through the observation of historical II World War acquisitions first, and thanks to the very high spatial resolution of optical satellites later. The present research constitutes a contribution to the non-invasive archaeological investigation methodology carried out in the last years by several institutions and cultural organizations.

The work aims to exploit the technique of SAR Polarimetry for the detection of surface and subsurface archaeological structures, comparing ALOS PALSAR L-band, with a central frequency of 1.27 GHz, with RADARSAT-2 C-band sensor, whose central frequency is 5.405 GHz. The choice to analyze satellite radar sensors capabilities is based on their 24-hour observations, as they are independent from Sun illumination and meteorological conditions. Moreover, they could provide additional information concerning electromagnetic properties of the target, qualities not derivable from optical images.

A multi frequency comparison between the two SAR sensors has been performed over the Napatan (900-270 BC) Meroitic (270 BC-350 AD) area of Djebel Barkal, located in Sudan and inscribed in the UNESCO World Heritage List since 2003. It constitutes one of the five Napatan and Meroitic archaeological sites stretching over more than 60 km in the Nile valley, in an arid area part of Nubia. The area, not completely excavated, presents thombs, pyramids and sacred palaces.

The dataset we disposed of is composed of two archived ALOS PALSAR polarimetric images and four RADARSAT-2 polarimetric data specifically acquired in the same year (2012). All the products have been then processed and integrated with the available optical data and the cartographic documentation derivable from UNESCO reports over the area. A multitemporal analysis has been also performed thanks to the notable difference in time acquisition between ALOS PALSAR and RADARSAT-2 data.

The great potential of the two polarimetric instruments with different frequency for the detection of archaeological remains has been demonstrated thanks to the sand penetration capability of both C-band and L-band sensors.

The possibility of monitoring and observing ancient sites by means of remotely acquired SAR data could be an added value to the archaeological research, especially for those areas in which instable political situations do not allow ground truth and surveys *in situ*.