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Remote estimation of dielectric properties of palaeochannel-fill sediments in Tubas Area, Namibia: implications for surficial uranium exploration

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Surficial uranium concentrations in the form of calcrete-hosted carnotite deposits are highly sought-after because of low mining and extraction costs. These deposits form by precipitation of uranium-potassium vanadate (i.e., carnotite) from ground waters in very-near- to near-surface environments in Tertiary to Recent palaeochannels that are etched over ancient basement rocks in hot, tropical, and arid to semi-arid regions. Economic concentrations of carnotite require pooling of ground waters in areas of low hydraulic gradient. The two major challenges in exploration targeting of surficial uranium deposits are (a) identification of palaeochannels, particularly when they do not have any surface expressions, and (b) delineation of segments of low hydraulic gradients within palaeochannels.

Since the dielectric properties of channel-fill sediments are expected to be different from the wall rocks as well as the floor rocks, remotely estimated dielectric profiles can be used to identify palaeochannels as well as potential locations for surficial uranium mineralization in the delineated palaeochannels. In the present study, we used Advanced Land Observation Satellite (ALOS) Phased Array type L-band Synthetic Aperture Radar (PALSAR)-1 fine resolution quad polarization data from Japan Aerospace Exploration Agency (JAXA) to estimate the dielectric properties of channel-fill sediments in the palaeochannels in the Tubas and Tumas area, central Namibia.

The full polarimetric Synthetic Aperture Radar (SAR) information contained in the L-Band single-look complex format data was utilized to derive the generalized volume parameter, which is directly related to Fresnel Transmission Coefficient, and was inverted to obtain dielectric constant. A series of dielectric profiles across the study area were drawn and it was found that that palaeochannels are characterized by steep changes in the dielectric permittivity, which do not correlate with the topography. These results indicate that the changes in dielectric permittivity may be related to the thickness of palaeochannel-fill sediments. The profiles were used to demarcate palaeochannels in the area. The field-verified palaeochannel map of the Tubas area would be presented.