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Mapping of Zones of Hydrothermally Altered Rocks Based on the Processing and Analysis of WorldView-2 Data: On Example of the Talman Site (Southeastern Transbaikalia) †

Ishmukhametova V. T., Nafigin I. O., Ustinov S. A., Lapaev D. S., Minaev V. A. and Petrov V. A.

The Organization of Russian Academy of Sciences, Institute of Geology of Ore Deposits, Petrography, Mineralogy and Geochemistry, Russian Academy of Science; email1@email.com (I.V.T.); email2@email.com (N.I.O.); email3@email.com (U.S.A.); email4@email.com (L.D.S.); email5@email.com (M.V.A.); email6@email.com (P.V.A.)

* Correspondence:

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Abstract:

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The current stage of development of geological exploration and reproduction of the mineral resource in Russia is focused on the discovery of new ore deposits. In mountainous regions in a variety of landscapes, secondary geochemical halos and dispersion flows of ore deposits are clearly manifested on the modern earth surface. An industrial deposit lying in the thickness of ore-bearing rocks, or the smallest manifestation of a mineral of any mineral raw material, being a geochemical anomaly in itself, forms lithochemical anomalies in loose weathering products. Taking into account one of the main limitations of the use of remote sensing methods in geology, namely the depth of surface exploration, the proposed method is reduced to revealing the manifestation of secondary scattering halos on the day surface, i.e., mapping zones of hydrothermally altered rocks and products of hypergenesis, identification of iron oxides/hydroxides in soils and rocks, in particular.

The geological information content of the WorldView-2 data lies in the high spectral resolution and the presence of VNIR bands, which allow displaying detailed spectral characteristics of surface objects, in particular, minerals of the iron oxide/hydroxide group containing transitional iron ions (Fe^{3+} and Fe^{3+}/Fe^{2+}) that are part of the zones wall-ore hydrothermally altered rocks. In accordance with the absorption spectral features of a group of minerals (hematite, magnetite, goethite, ilmenite, jarosite, limonite) containing iron oxides and hydroxides, the spectral band ratio technology (mineralogical indices) was used for WorldView-2 VNIR channels. The mineralogical index (b3*b4)/(b2*1000) (Segal, 1982) was used to map Fe^{3+}/Fe^{2+}; for ferric iron mapping, the mineralogical index (b4 + b2)/b3 (Pour, 2019) was used; mineralogical index (b6 + b8)/b7 (Pour, 2019) was used to map ferrous iron.

Then a pseudo-color RGB composite, which displays the classes of geological materials that have spectral characteristics associated with iron oxides/hydroxides was created. The R band corresponds to Fe^{3+}, the G band corresponds to Fe^{3+}/Fe^{2+}, and the B band corresponds to Fe^{2+}. Thus, this color combination well emphasizes the geostructural characteristics of rocks associated with hydrothermal changes. According to the authors, the selected pseudo-color RGB composite is the most informative for mineralogical mapping of the study area (Figure 1).

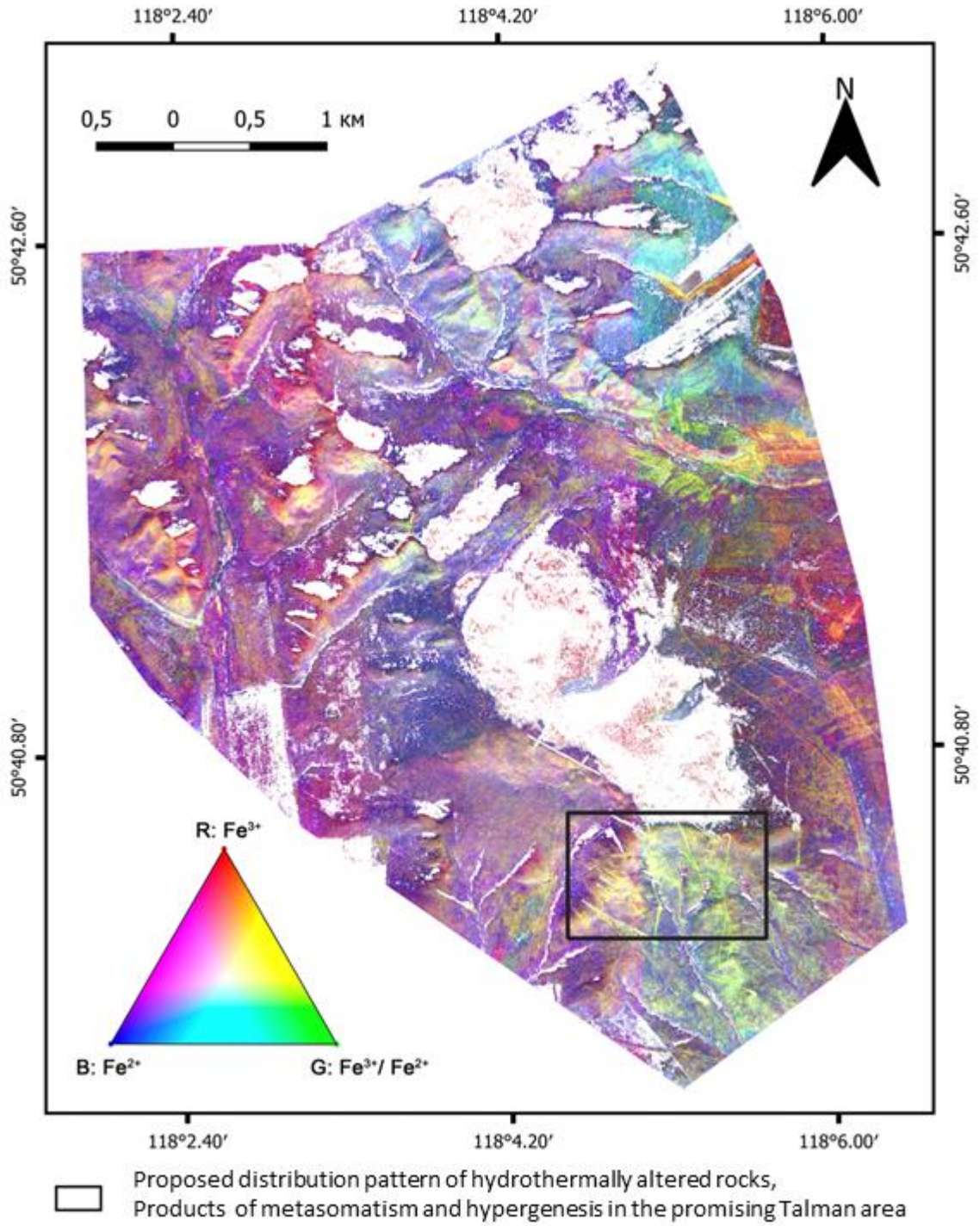

Figure 1. False-color composite based on bands ratio method (R: (b4 + b2)/b3, G: (b3*b4)/(b2*1000), B: (b6 + b8)/b7).

According to the proposed WorldView-2 data processing method and the selected RGB pseudo-color composite (Figure 2), the resulting image is presented as a minerals map of the probability distribution of oxides/hydroxides containing transitional iron ions (Fe^{2+}, Fe^{3+} and Fe^{3+}/Fe^{2+}), which assigns a mineral to each pixel, conditional the probability of occurrence of which at a given point is maximum. The revealed spectral anomaly corresponds to the supposed dispersion haloes of the products of metasomatism and hypergenesis.

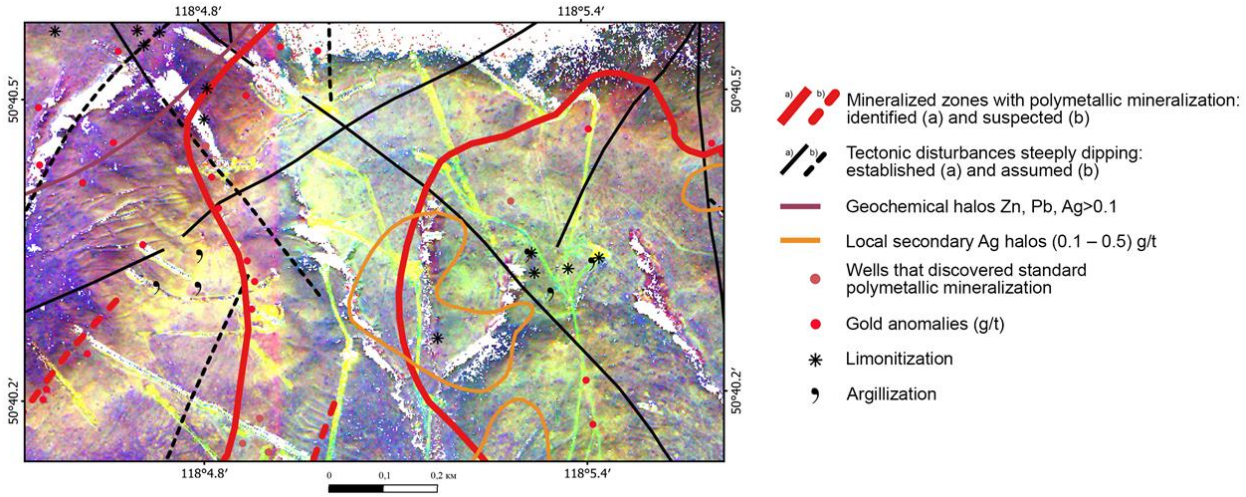

Figure 2. Estimated distribution pattern of hydrothermal alterations and hypergenesis products in the study area.

The results obtained using modern methods of processing remote sensing data allow us to consider the spectral anomalies of the zones marking near-ore changes in rocks as an indicator for substantiating the choice of areas for detailed exploratory studies within ore clusters. The results of such studies can significantly reduce the cost at different stages of geological exploration.

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Conflicts of Interest:

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