New approaches to geochemical exploration for deep-seated and covered mineral deposits

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At present, because of the urgent need to carry out exploration for deep-seated mineral deposits, as well as deposits within areas covered by drifts, it is necessary to create and develop new geochemical techniques which are deep-penetrating ones and enable revelation of such concealed ore deposits. Routine geochemical prospecting surveys are not effective enough in such terrains due to low contrast or absence of geochemical anomalies related to ores.

Among the deep-penetrating geochemical methods based on the phenomenon of jet-flow vertical migration of chemical elements from the deep to the surface resulting in superimposed dispersion halos formation, is the Method of Analysis of Superfine Fraction (MASF) developed in VSEGEI that uses extraction and analysis of superfine fraction of soils (<3-10 μm) where superimposed dispersion halos occur. These halos are predominately created by the process of secondary fixation of mobile forms of elements due to the sorption of metals from the gaseous and water upward flows by clays, Fe and Mn hydroxides, and other natural substances. MASF surveys use sampling of definite horizons of soils and/or stream sediments, extraction of superfine fraction from samples by means of special technology, determination of contents of indicator elements using ICP-AES, ICP-MS, AAA with specific sample preparation, and geochemical data processing and interpretation with the help of original algorithms.

Another perspective technique is the geochemical prospecting using water-extractable and weak-acid-extractable forms of chemical elements (mobile ions) from soils and stream sediments. Resultes of our survey carrried out in the Far East region has shown that most reliable prediction of gold mineralization can be distinguished by getting together data obtained by both mentioned deep-penetrating geochemical techniques.

Nisa granitic massif: SHRIMP zircon U-Pb age and source constraints

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The Nisa granitic massif crops out over an area of 1000 km^2 in SW Iberia. It is a zoned batholith dominated by a rim consisting of very coarse-grained porphyritic two mica S-type monzogranite-syenogranite and a discontinuous core of very fine-grained I-type tonalite-granodiorite. To constrain the age relationships and petrologic processes responsible for this zonation, SHRIMP $^{206}Pb/^{238}U$ zircon ages were obtained for the monzogranite and tonalite. Zircons from the monzogranite are typical of granitic rocks and can be broadly classified into three texturally and chemically distinct types: 1) high-U, low Th/U outermost overgrowths (307.4 ± 4.0 Ma); 2) moderate U and Th/U zircon with concentric zoning occurring both as inner overgrowths and whole grains (305.4 ± 6.2 Ma) and 3) texturally discordant cores (309.0 ± 4.6 Ma and inherited). It was impossible to identify in advance, on any textural basis, which cores were 'young' or inherited. Despite textural and compositional contrasts the three "young" zircon types have mutually indistinguishable ages. Zircons 1) and 2) represent different stages of igneous zircon growth and zircon 3) must represent an earlier stage of growth. Either the protolith of the monzogranite contained some zircon slightly older than the monzogranite itself or zircon grew in two stages, separated by a period of zircon undersaturation. The former hypothesis seems to be unrealistic in the regional geological context. The latter would be possible if the magma was reheated soon after cooling to the point of zircon saturation. This is consistent with the dissolution features found in some of both older and younger cores. There is a very marked chemical contrast between zircons 1) and 2), as Th/U in 1) is almost 10x lower than in 2), which is compatible with saturation of monazite at a late stage of crystallization and/or the presence of U-rich fluid soon after the monzogranite was intruded. The inherited old cores fall broadly into Neoproterozoic, near concordant ages (506–661 Ma), and Paleoproterozoic and older, mostly discordant ages (1.85–2.55 Ga). There is a noticeable absence of Mesoproterozoic ages, which is significant in a regional geodynamic context. In contrast, zircons from the tonalite have banded zoning that is typical of zircon from mafic igneous rocks, and inherited cores were not found. Further, their Th/U is generally >1, higher than in zircon from the monzogranite. Their age, 306.2 ± 3.0 Ma, overlaps the ages of the three generations of zircon from the monzogranite, but zircon features suggest different sources for these two granitoids. The tonalite protolith might have been a more refractory level that melted soon after the crystallization of the "young" zircon cores from the monzogranite due to an increase in temperature (causing zircon dissolution). Tonalite in the core of the batholith probably intruded immediately after the dominant monzogranite rim.