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GEOCHEMISTRY OF NATURAL AS, F AND U SOURCES TO GROUNDWATER IN THE MEXICAN SIERRA MADRE OCCIDENTAL

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Fluoride, arsenic, and uranium are naturally occurring trace elements that can cause adverse health effects in exposed human populations. The igneous rocks and basin fill sediments in the cities of Chihuahua, Zacatecas and San Luis Potosí, Mexico (Sierra Madre Occidental), have partly elevated contents of these elements that are often attributed to felsic volcanic sequences; however, the specific host phases and mobilization processes to which anomalies can be credited are rarely identified. Through detailed total rock analysis (W%), scanning electron microscopy (SEM), Raman spectroscopy, electron microprobe (EMP), and laser ablation (LA-ICP-MS), mineral and amorphous phases (glassy matrix) hosting these elements were identified. Fluorine-rich minerals like fluorapatite (≈ 2.24 W%), biotite (≈ 2.23 W%) and glassy matrix rich in As (0.28 - 392 ppm) and U (0.56 - 21 ppm) are mainly found in rhyolites and ignimbrites belonging to the Tertiary volcanic outcrops of the tectonostratigraphic province of the Sierra Madre Occidental, and basin-fill sediments derived from these rocks. The solid phase F, As, and U fractionations were characterized by means of a modified selective sequential extraction procedure (SEP), which was developed for targeting the easily soluble fraction, the one linked to carbonates, iron oxyhydroxides, apatite, total amorphous silica, and residual silicates. The results showed that F is mainly linked to the apatite and the silicate portion (biotite), while As and U are strongly related to the fraction associated with the vitreous matrix (analysis still in process). Based on the present study, the As, F, and U anomalies in the different study zones are associated with ignimbrites and rhyolites considered as the potential primary source, where some matrix alteration textures such as spherulitization and devitrification (present in the rocks) favors the mobilization of these elements to the environment. The methodologies and results obtained can be transferred to other semi-arid regions with geogenically impacted zones, due to the geological and climatic similarity with numerous volcanic-sedimentary basins around Latin America and other parts of the world.