The Xitieshan volcanic sediment-hosted massive sulfide deposit, North Qaidam, China: Lithogeochemistry and Paleotectonic setting of basic volcanic rock from the Tanjianshan Group

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The Tanjianshan Group is an important part of Middle to Lower Ordovician volcanic sedimentary complex rocks in the middle part of the north Qaidam orogenic zone, which developed along the margin between the Qaidam block and the Qilian block. The Xitieshan massive sulfide deposit occurs at the lower stratigraphic horizons within the volcano-sedimentary package of the Tanjianshan Group. Geochemical data are presented for the least-altered units from the two major volcanic sedimentary cycles of the basic volcanic rocks in the Xitieshan district. Four major mafic assemblages are recognized by the data from the older to the new, or from the a Formation to the unit d-3, they are the OIB-like basalt, back-arc basin basalt (BABB), MORB-like, and evolved subduction-influenced tholeiite back-arc basin basalt, respectively.

The earliest phase of mafic volcanism from the a Formation is typical character of oceanic arc-back-arc volcanism and subduction processes, the a Formation is characterized by the calc-alkalic, pronounced LREE enrichments, moderately flat HREE patterns, negative Zr and Hf anomalies, the elevated La/Nb (3.07-11.29), was probably produced by partial melting of attenuated subcontinental lithospheric mantle during fractional crystallization. The unit d-1 is characterized by the typical BABB, transitional, intermediate between enriched mid-ocean ridge basalt and ocean island basalt, elevated Al2O3 content (15.67~22.57, avg. 19.61), produced by fractional crystallization and assimilation-contamination of mafic magma. The MORB-like unit d-2 is characterized by the smoothly flat REE to LREE depleted, absence of pronounced HFSE anomalies, low Th and moderate negative Nb anomalies that indicate derivation from relatively depleted MORB-like asthenospheric mantle variably modified by subduction process. The characteristic of the d-3 unit is similar to the a Formation, which is moderately slope and LREE enrichment, slightly negative Nb, Ta, Zr, Hf, and Ti anomalies relative to the a Formation, is likely product of the dilution of subduction-modified mantle material by upwelling asthenospheric mantle as the subduction zone becomes more remote from the principal site of back-arc basin magma generation.

Generally, four basic volcanic rock types within the Tanjianshan Group were deposited in an integrated back-arc basin system developed by extension of continental lithosphere along the north Qaidam terrane margin in the Ordovician, based on their geochemical characteristics and comparisons with other ancient analogous volcanic tectonic setting and massive sulfide deposit depositional environment. A successively gradual shift, from subduction related island arc volcanic of the a Formation, through the typical back-arc basin basalt (BABB) of unit d-1 to the E-MORB of unit d-2, and lastly subduction BABB of the d-3 unit, is the evolutionary process of the typical back-arc basin systematics, which formed under the rapid change in stress mechanism from compressional to tensional and return to compressional along the convergent margins of the Qilian block. The Xitieshan deposit formed during a period of active felsic volcanism and sedimentation within back-arc basin. The main mineralizing events follow the eruption and deposition of the a-l
unit silicic magmas and are synchronous with the onset of back-arc volcanism produced by partial melting of subduction-modified mantle during the upwelling of basaltic magma.