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Temporal evolution of magmas associated with Au-Cu mineralization in the Hualgayoc Mining District, Northern Peru.

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The Hualgayoc mining camp in the northern Peruvian Cordillera hosts the Cerro Corona Au-Cu porphyry, Tantahuatay high sulfidation Au, AntaKori skarn deposits and many other Au and Cu prospects. Our new U-Pb zircon dating shows that all igneous rocks formed during three pulses of Miocene magmatism; 14–15, ~13–12 and ~9 Ma. The oldest event produced rocks in the eastern part of the district, including the Cerro Corona intrusive complex. They are diorite to granodiorite with phenocrysts of Hbl±Bt and Mag. Bulk rocks have high Sr/Y (40–90), moderately low Y (8–16 ppm) and $[La]_N/[Yb]_N$ (9–18), and low $[Dy]_N/[Yb]_N$ (1.4-1.1), suggesting that the magmas originated from lower crust with residual amphibole. The water-rich magmas suppressed plagioclase crystallization to cause high Sr. Zircon grains from the suite of intrusions show consistent $[Yb]_N/[Dy]_N$ around ~9, suggesting essentially no amphibole fractionation during zircon crystallization. Ce/Ce* ($=[Ce]_N/[[Nd]_N]^2/[Sm]_N$) in zircon increase with decreasing temperatures. To compensate temperature effects, Ce/Ce* were normalized to 690 °C. The normalized Ce/Ce* of the oldest suite of rocks range between 108 and132, reflecting moderately oxidized parental magmas. The second magmatic event, 13-12 Ma, occurs in the western part and produced Qz-Pl porphyry intrusions and andesitic to rhyolitic volcanic rocks. They host the Tantahuatay and AntaKori deposits. The values of $[Yb]_N/[Dy]_N$ in zircon show an increase from ~5 to ~12 during magma evolution, suggesting the presence of amphibole±garnet at the source and subsequent amphibole±titanite fractionation. Zircon grains show high normalized Ce/Ce* (118–200), reflecting highly oxidized parental magmas. The findings suggest that the oxidation state of magmas increased as the source changed from a garnet-free to garnet-bearing over a span of ~3 Ma. High oxidation state for all magmas is consistent with the alteration and types of mineralization in the area.