Mantle origin for gold associated with the Yellowstone Plume

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The timing and mantle or crustal origin of gold mineralization in many world-wide locations can be controversial but is important for informing resource models. Numerous studies have applied the ^{187}Re-^{187}Os (half-life 42 Ga) system to sulfides associated with gold, but fewer studies have directly analysed gold itself. Here we report $^{187}Os/^{188}Os$ ratios and highly siderophile element (HSE) concentrations for electrum grains (70:30 Au:Ag) and host basaltic rocks from the Fire Creek Deposit, Northern Nevada Rift. Fire Creek is one of >15 mid-Miocene bonanza grade epithermal Au-Ag deposits related to inception of the Yellowstone plume and the formation of Columbia River flood basalts. Host basalts (4 to 7.5 wt.% MgO) have fractionated HSE patterns and radiogenic measured $^{187}Os/^{188}Os$ (0.33 to 1.78). Electrum grains also have fractionated HSE patterns (Pt/Ir = 14 to 265), high Re/Os (30-1270) but a more restricted range of measured $^{187}Os/^{188}Os$ ratios (0.1454 to 0.88). Correlations of $^{187}Re/^{188}Os$-$^{187}Os/^{188}Os$ for electrum yield a mid-Miocene age, and an initial $^{187}Os/^{188}Os$ composition of 0.159. The Os isotope composition of the gold is distinct from typical crustal $^{187}Os/^{188}Os$ (>>0.5), and within the range of $^{187}Os/^{188}Os$ measured in modern mantle-derived melts (0.125-0.17). Our results unequivocally demonstrate that precious metals were derived from mafic magmas formed during impingement of the Yellowstone plume under western North America ~16 million years ago. Gold was likely transported from mantle-derived melts by exsolved volatiles. The gold was subsequently incorporated into meteoric water-dominated epithermal systems leading to precipitation of native electrum and disseminated gold in bonanza ores.