

# Variation in Placer Style, Gold Morphology, and Gold Particle Behavior Down Gravel Bed-Load Rivers: An Example from the Shotover/Arrow-Kawarau-Clutha River System, Otago, New Zealand

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## Abstract

Gold eroded from quartz veins on the slopes of actively uplifting and physically weathering tributary catchments is transported to the fluvial system with little modification by mass movement mechanisms. Gold concentrates initially in the bed-load component of spatially limited, high-grade, primitive placers in moderate- to high-gradient, incised, juvenile valleys in which the rivers flow on or near bedrock. Interglacial and/or uplift-induced downcutting events and major floods periodically reconcentrate gold into lags on bedrock. Maximum gold particle size increases for the first few kilometers of primitive placers then decreases progressively downstream. Coarse gold ( $>3$  mm,  $>0.5$  g) and gold with low flatness index ( $<7$ ) becomes lodged in bedrock crevices and is only remobilized by bedrock erosion. Gold undergoes minor to moderate rounding in primitive placers but little or no flattening or folding.

Gold transported through primitive placer valleys enters the bed load of a short, lower-gradient, transition zone and then the trunk river system. Spatially extensive, moderate- to low-grade trunk placer deposits form in basins where trunk rivers emerge from gorges. Basin uplift, interglacial downcutting, and major floods periodically reconcentrate bed-load gold into intraformational or basal lags in the trunk rivers. Gold flattening and folding commence in the transition zone, and flatness index maxima, roundness, and the proportion of folded particles increase progressively down the trunk rivers. Distal trunk placer gold is typically up to 2 mm in size, has a relatively high flatness index ( $>10$ ), and is well rounded and commonly folded.

Flattening progressively increases both the surface area-to-volume ratio and the entrainment potential of gold particles. A reliable relationship between fluvial transport distance and flatness index maxima throughout the river system defines a critical flatness index above which gold is entrained and below which gold is not transported. At given values of river gradient, velocity, and bed roughness, both entrainment and retention of gold in primitive placer valleys are controlled by shape and mass characteristics that are largely inherited from the primary sources. In transition and trunk placer valleys, gold entrainment is controlled by flattening of particles to a critical flatness index state, whereas gold retention is controlled by flatness index reduction to subcritical state by particle folding, as well as input of relatively proximal, locally derived, primary or paleoplacer gold with subcritical flatness index or mass.