TECHNICAL GUIDE

ALLUVIAL GOLD SMELTING

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The final product from alluvial / placer gold mining operations is marketed as bulk concentrate (lose grains) or gold ingot / bullion. Bulk concentrate is a good option where there is a close relationship between the producer and buyer and where the buyer is better equipped and experienced with smelting. Gold bullion on the other hand is more quality - consistent for added confidence in the gold content and allows for more secure transport without the risk of partial loss, theft or tampering between producer and buyer.

In this article, the practice of smelting alluvial gold into ingots or bullion is discussed.

Smelting success requires gold concentrate to be clean. We recommend at least 70% Au content. Consider that clean alluvial gold grains, depending on their origin, contain 80-90% Au (equal to 800-900 Fine = 19-22 carat), the other 10-20% typically being silver alloyed with the gold. Hence, there is only a narrow margin for mineral contamination (i.e. non-magnetic black sands) in the bulk concentrate before it is considered “dirty” for smelting. Dirty concentrate (no less than 50% Au content) can be smelted but results in dirtier bullion and potentially excessive gold lockup in the slag phase. The established process to generate clean concentrate requires multiple upgrading steps, including classification, gravimetric upgrading, and magnetic separation. Refer to Macon Industries’ GR20 and GR40 gold room models for complete solutions.

Fig 1 – Clean gold concentrate

Fig 2 – Magnetite removal from final concentrate

Clean alluvial bulk gold concentrate needs to be dried for removal of remaining magnetite and weighing. Fluxes are added based on weight and records allow for the calculation of the melt loss later.

The two flux components used for smelting placer/alluvial gold:

Anhydrous Borax ($Na_2B_4O_7$) lowers the melting point of minerals and metals and forms a glassy slag to contain impurities. Soda Ash (Na_2CO_3) is an alkaline flux that helps in breaking down impurities and forms a fusible slag.

	Gold Concentrate	**Anhydrous Borax ($Na_2B_4O_7$)**	**Soda Ash (Na_2CO_3)**
Clean Alluvial Gold Concentrate (> 70% Au)	100%	50%	50%
Example (gram)	1,000 gram	500 gram	500 gram
Dirty Alluvial Gold Concentrate (> 50% Au)	100%	0%	100%
Example (gram)	1,000 gram		1,000 gram

Gold concentrate and fluxes are mixed before they are added to the crucible. The crucible size should be large enough to prevent boil over - it is recommended to not fill the crucible more than 50% volume.

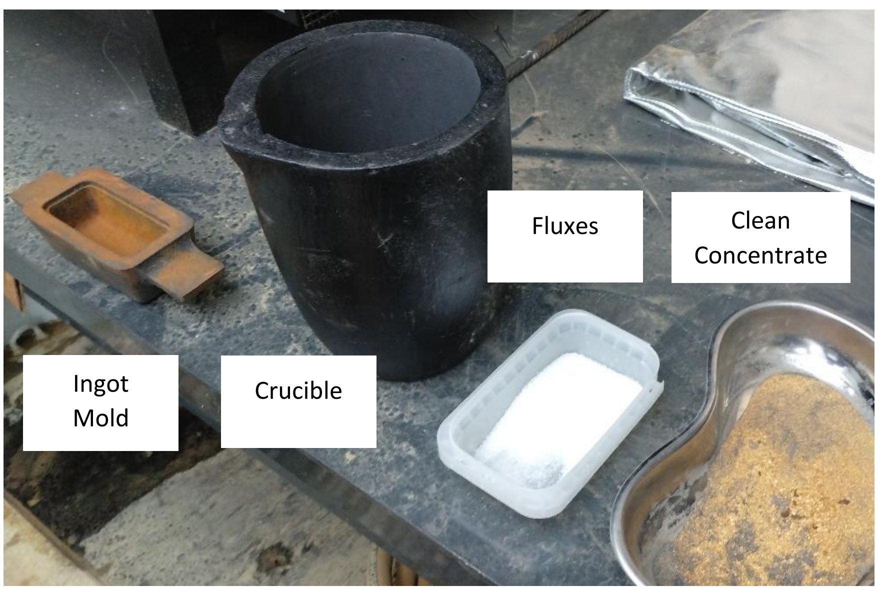

Fig 3 – Smelting Tools and Components

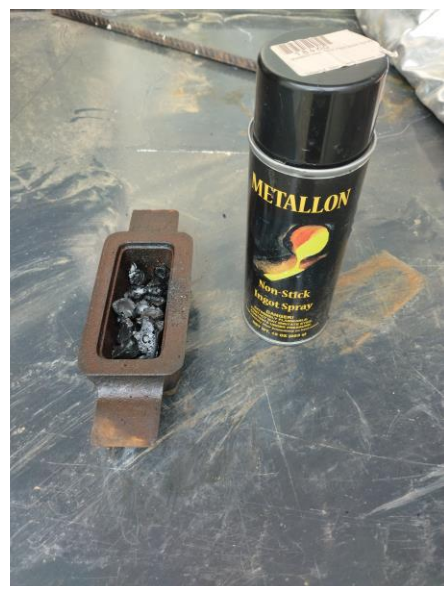

Fig 4 – Non-Stick Ingot Mold Spray

Most common types of smelting furnaces are electric or propane fired. Electric furnaces allow for good temperature control, while propane furnaces are simple and robust. The charge melts in a graphite or clay crucible in the furnace and is then then poured into a cast iron ingot mold to form the bullion.

With the crucible inserted, the furnace temperature is brought to approximately 1,700 -2,000 degF (930 - 1,100 degC). The life of electric heating elements can be prolonged if the temperature is kept low, just above the required temperature to melt the charge. If the furnace is not equipped with a temperature controller, a handheld infrared thermometer can be used to gauge the melt temperature.

Once the charge is molten, stir with a carbon rod or rebar rod and then continue to cook the charge for at least another 30 minutes. The appropriate size mold shall accommodate the volume of metal. The mold shall be coated with acetylene soot or ingot spray to ensure easy ingot release. Pre-heat the mold prior to pouring, this can be accomplished in front-load furnaces, provided there is enough space, by placing the mold into the furnace, besides the crucible, for the final 15-30 minutes prior to pouring.

The hot mold is mounted over a slag pot to contain any potential slag overflow or spillage. The molten charge is poured from the crucible to the mold in one continuous movement and left to cool. Once cooled, the bullion is removed from the mold and slag is separated. Inspect slag for general appearance and entrained gold beads, which can be recovered after crushing/grinding the slag.

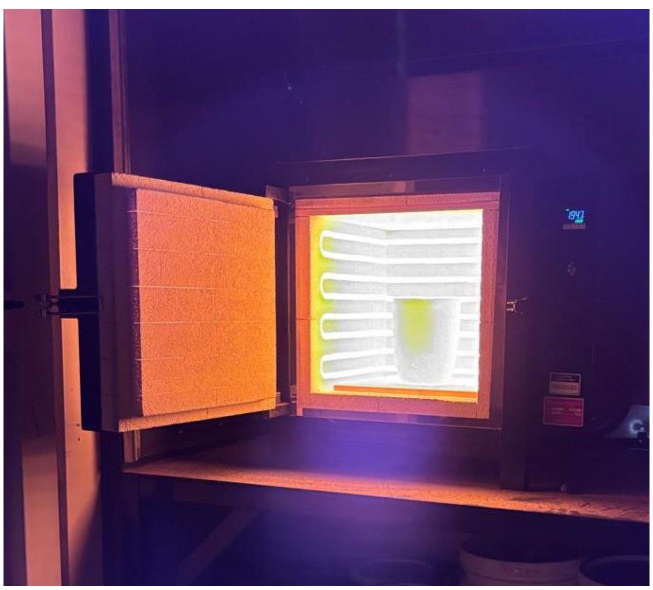

Fig 5 – Crucible heating in an electric furnace

Fig 6 – Gold pour from crucible into ingot mold

The weight of the gold ingot / bullion is recorded to calculate the melt loss, which should be no more than 20% compared to the mass of the clean concentrate added to charge the crucible. High melt loss is an indicator for excessive contamination of the concentrate or gold lockup in the crucible or slag. The metallic composition of bullion will be similar fineness to natural gold grains and depends on the origin, typically ranging from 80-90% Au = 800-900 Fine = 19-22 Karat. Silver will remain with the Au-Ag bullion alloy. The separation of silver from gold (the process of "parting") is performed by the refinery/mint.

The bullion may be drilled using a 1/8" (3mm) drill bit, this shall be done from both sides or though the bullion, while retaining shavings (approx. 1-3 grams) for Au assay by an independent assay lab for quality control or umpire. It is good practice to add an identifier to the bullion, using stamp letters.

Fig 7 – Gold bullion after pouring

Fig 8 – Visual inspection of slag

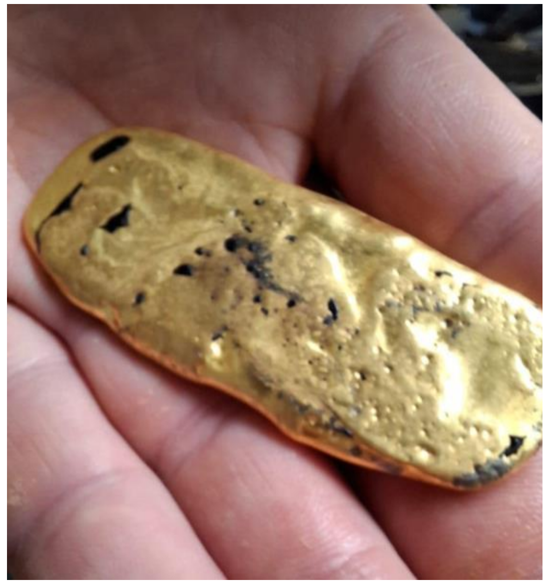

Fig 9 – Gold Ingot / Bullion

In summary, the smelting of alluvial gold concentrates is an established and reasonable option for experienced operators aiming to deliver consistent quality gold bullion to the market.