

### 3: Chlorine – chemical leaching of gold

Chlorine had been used to recover gold for a couple of hundred years, notably to leach gold from residues of Hg amalgamation. Later chlorination found favour in large gold mining operations in Australia and the USA but has now largely disappeared [34]. Chlorination is safer and simpler than cyanide, and can challenge mercury.

By the 1970s, chlorination had been largely forgotten. Yet, as noted by WWF-Guianas ([www.wwfguianas.org](http://www.wwfguianas.org)), a basic version of chlorination could replace amalgamation and cyanide, and the following account is based largely on their report [35]. Two common chemicals are required:

- ✘ **bleach** – 14-16% sodium hypochlorite NaOCl (household bleach) but products often have additives that may interfere with the process. Training and precautions are ESSENTIAL.
- ✘ **hydrochloric acid** – 30% HCl strength, as for cleaning swimming pools. Training and precautions are ESSENTIAL.

However bleach (sodium hypochlorite solution) forms comparatively stable trihalomethanes (THMs) and haloacetic acids (HAAs) claimed to be carcinogenic and posing other health risks [36]. Only in 2001 was this addressed by Mintex's 'iGoli method', as discussed in a later section [37-40].

#### Operation

The floor is sealed, and a tap plus plastic garden hose kept ready to flush spillages of bleach and acid. The operators must be trained and clad in rubber gloves, rubber apron, laboratory eye-protectors and rubber boots.

#### Preparation – removal of carbonates

The first task is to dissolve carbonates as they can interfere with leaching gold. A stock of STRONG 30% HCl is added to water to produce 15% dilute HCl. The concentrate is put in a lidded plastic bucket and 15% HCl added to submerge the concentrate, using a plastic rod to stir. A long handle cut from a plastic sweeping brush is ideal.

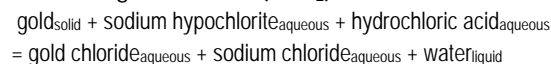
Frothing and foaming may push off the lid causing spills, especially if the concentrate has calcite or dolomite as vein material, rocks (e.g. limestone) or coatings. The foaming is carbon dioxide CO<sub>2</sub> gas liberated when HCl dissolves carbonate.

When dissolution seems over, the lidded bucket is stirred again and left overnight to allow the process to terminate. Next day the acidity is checked by pH paper (litmus test). If not slightly acid then the acid was completely used, so more 15% HCl is added until the process is complete. Then the bucket is stood for several hours to settle, and surplus water gently tipped away.

#### 1<sup>st</sup> stage – leaching gold into solution

A plastic pole is used to make a hollow in the concentrate, and the bleach gently stirred in. Shortly after, the 30% HCl is poured in, taking MAXIMUM precautions, stirring the concentrate with the pole.

Gold is dissolved ('leached') by attack by nascent chlorine to form gold chloride (AuCl<sub>2</sub>) in solution:



#### 2<sup>nd</sup> stage – recovering gold from solution

The liquid is decanted from the bucket and filtered. The filtrate includes leached gold as gold chloride<sub>aqueous</sub>.

To precipitate the gold from the pregnant solution, several methods are available: sodium metabisulphate, zinc metal (chunks, bars or powder), oxalic acid, ferrosulphate or sodium nitrate. Sodium metabisulphate was used by WWF-Guianas [35]. Zinc often has cadmium (Cd) as impurity that is toxic if released.

#### Adoption by placer gold miners

Chlorination is a neglected method for recovering gold from placer concentrates and the author is unaware of any companies using this method, although some artisanal placer miners may be doing so.

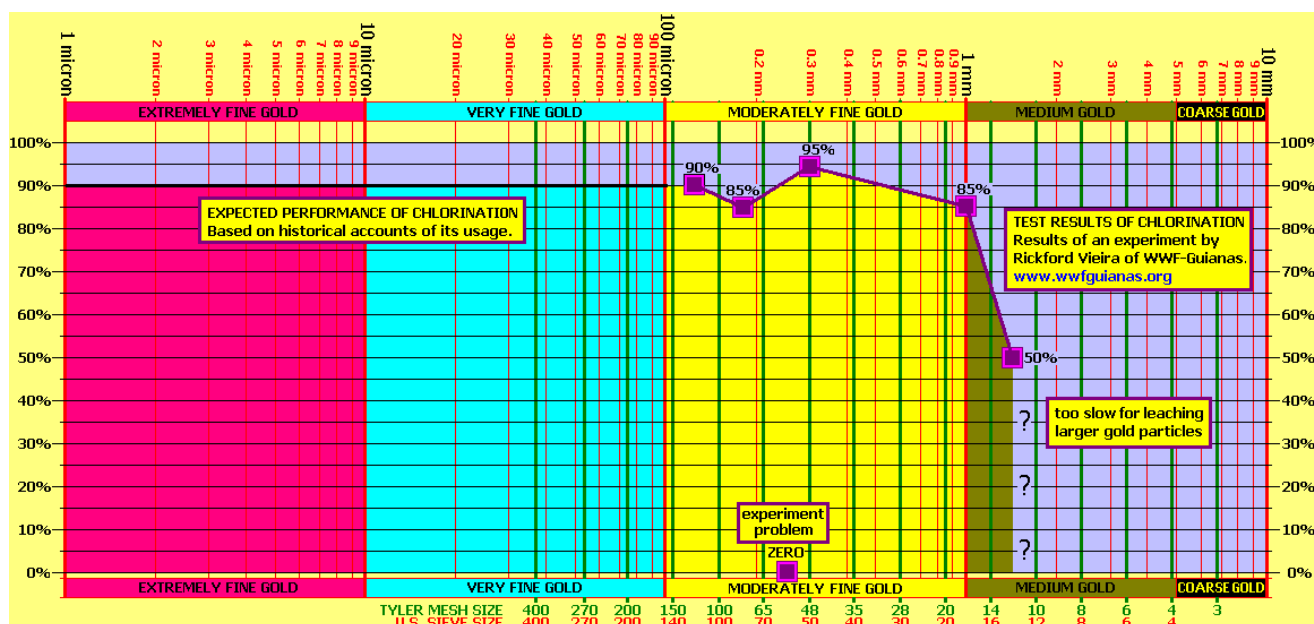


Figure 17. GOLD RECOVERY BY CHLORINATION  
Chlorination can dissolve (leach) about 90% of gold <300µ but is too slow for leaching larger gold. [35] (compiler: Robin Grayson)