

A new method for determination of preg-robbing in gold ores

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Received 5 April 2005; accepted 30 May 2005

Abstract

A new method utilising standard additions of gold for the initial characterisation of preg-robbing potential for a variety of ores is proposed. The method is compared with the Barrick Gold Mines Incorporated (BGMI online) preg-robbing test currently used in industry and shows good correlation for carbonaceous ores. It is shown that for silicate and sulphide ores the residence time of the BGMI preg-robbing test is too short to allow equilibrium to be achieved and in all cases it was demonstrated that allowances in the BGMI preg-robbing test need to be made for gold leached from the ore.

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Keywords: Precious metal ores; Leaching

1. Introduction

Gold losses during processing are a major problem throughout the gold mining industry and if not properly identified, they can lead to significant amounts of gold reporting to tailings. One of a number of phenomena by which these gold losses occur is known as preg-robbing, whereby constituents of the ore adsorb the aurocyanide complex from solution. These ore constituents can be carbonaceous matter present in the ore or they can be the minerals themselves, such as sulphides or silicates.

The characterisation of the preg-robbing potential for gold ores is of great importance to processing. While a number of methods exist for fast online determination of this phenomenon little work has been performed on the initial characterisation of preg-robbing and its relation to refractoriness.

2. Preg-robbing

The most common and well documented cause of preg-robbing is carbonaceous matter present in the ore. This can be in the form of heavy hydrocarbons, organic acids or natural carbon (Osseo-Asare et al., 1984). Of this material, native carbon is the most important species for preg-robbing. Heavy hydrocarbons do not interact with gold (Osseo-Asare et al., 1984) and although Radtke and Scheiner (1970) suggested that organic acids could adsorb gold, Stenebraten et al. (1999) demonstrated recently by GC-MS that they were unlikely to be a major factor in preg-robbing. Stenebraten et al. (2000) showed for ore from the Carlin trend, Nevada that the preg-robbing characteristics were inversely correlated to the L_c (002) crystallite dimension and directly related to the d-spacing of the carbonaceous material.

The other documented causes of preg-robbing are the minerals themselves, predominantly either sulphides or silicates. A number of investigations into the preg-robbing power of sulphide minerals have been performed. Quach et al. (1993) showed that chalcopyrite and

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pyrrhotite adsorbed gold from oxygen free solutions and Rees and van Deventer (2000) demonstrated a clear cyanide concentration dependence for preg-robbing on pyrite and chalcopyrite with very strong adsorption of gold in cyanide deficient solutions. Hausen and Bucknam (1984) also looked at the adsorption of gold on pyrite but suggested that preg-robbing would only occur if it constituted more than 40% of the ore.

Silicate minerals, especially clays have also been proposed as potential preg-robbars. It has been suggested that the positively charged edge surfaces of clay particles could attract negatively charged colloidal gold (Hausen and Bucknam, 1984). This can be seen in an electron micrograph presented by van Olphen (1977) that shows negative colloidal gold particles attached to positive kaolinite edges, although this was in acid solution and adsorption would be greatly reduced in an alkaline environment. A study by van Vuuren et al. (2000) on shale material from the Beatrix gold mine in South Africa demonstrated that gold was not adsorbed but that decomposition of phyllosilicates caused co-precipitation of gold with $Mg(OH)_2$ and $Fe(OH)_3$ phases. The propensity of gold to adsorb to clay minerals was also investigated by Hausen and Bucknam (1984) who showed that illite, kaolinite, montmorillonite and pyrophyllite did adsorb gold but to a much lesser extent than carbonaceous matter.

The mechanism by which preg-robbing occurs is largely dependent on the constituents in the ore causing the problem. Menne (1992) suggested that preg-robbing mechanisms can be divided into two types. Reversible (Type I) preg-robbing occurs by simple ion exchange of the large aurocyanide anion. This type of preg-robbing is common to some extent in most ores, but in most cases is reversible in the presence of activated carbon or by washing. Irreversible (Type II) preg-robbing is considered so because of the long time or unusually severe conditions required to redissolve the gold (Menne, 1992).

Type I preg-robbing provides few problems in modern CIP/CIL circuits if the activity of the ore constituents is less than that of activated carbon, however, constituents with a greater activity will compete strongly for adsorption of the aurocyanide complex. It has been shown for a number of ores, most notably those from Carlin, Nevada that native carbon will compete with activated carbon in this way (Osseo-Asare et al., 1984). The adsorption of gold onto native carbon is thought to follow much the same mechanism as the adsorption to activated carbon in a CIP/CIL circuit (Schmitz et al., 2001a,b) and although the number of active sites is smaller, it has been demonstrated that the adsorption kinetics are up to 4 times faster for native carbon (Hausen and Bucknam, 1984). For sulphide ores (Rees and van Deventer, 2000) suggested that preg-robbing was cyanide concentration dependent. In the pres-

ence of free cyanide it was shown that preg-robbing was unlikely to occur and any that did occur was easily reversed by the addition of activated carbon.

Irreversible (Type II) preg-robbing involves precipitation of the gold complex and can occur by a number of separate mechanisms (Menne, 1992). The first mechanism (Type IIa) involves a lack of available cyanide causing the aurocyanide complex to be stripped of one radical and the resulting auromonocyanide radical to form long chains, which are only vulnerable to attack from the tips making redissolution possible but very slow (Menne, 1992). A similar mechanism was presented by Rees and van Deventer (2000) who showed that aurocyanide was reduced to the surface of chalcopyrite in a cyanide deficient environment. The second mechanism for irreversible preg-robbing (Type IIb) is described by Menne (1992) as co-precipitation of gold with metal cyanides.

3. Preg-robbing analysis on the lab scale

A number of tests exist that are used extensively in industry. The simplest and most widely used method for determination of preg-robbing is the Barrick Gold Mines Incorporated (BGMI) preg-robbing test. This test is described by Schmitz et al. (2001a,b) and involves the addition of 10 ml of 2.0 g/l NaCN solution with 3 ppm gold to 5.0 g of ore. The resulting slurry is then equilibrated for 15 min and the solution analysed for gold. The concentration of gold lost from solution is then compared to the original concentration and a percent preg-robbing (%PR) value is determined. A similar method was proposed by Hausen and Bucknam (1984) that employed a longer residence time and determined a preg-robb value that was simply stated as the concentration of gold lost from solution. These methods were both developed for ores from the Carlin trend but are equally applicable to other preg-robbing ores.

The existing methods for determination of preg-robbing, although widely accepted, have been designed for online examination of changes in ore type. This is applicable to a production setting where relative changes in preg-robbing effects are of highest importance. However, these quick methods are not as applicable for initial characterisation of the preg-robbing potential of an ore and its relation to other ore characteristics because of uncertainty caused by the use of small sample sizes and leaching of gold from the ore within the residence time of the trial. A further development on the existing methods was the use of standard additions (Bader, 1980) to ensure reliability by using multiple assays to determine each preg-robb value. This approach placed more emphasis on the characterisation of preg-robbing as a stage of initial ore characterisation studies.

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