Tarkwaian Paleoplacer Gold Recovery Relationship with the Matrix
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ABSTRACT
The study was carried out to characterize selected conglomerates of the Banket Series of the Tarkwaian at Tarkwa area and related the textures and mineralogy to gold grade and recovery. The conglomerates contain 60-90% quartz pebbles, with the matrix being fine to medium and rarely composed of coarse-grained quartz. The gold ore also comprises of minor fine-grained ore minerals, sericite, and chlorite. The quartz pebbles were glassy, milky and partially recrystallized into sugary varieties. Primary sedimentary textural characteristics of sub-rounded to rounded pebbles of about 0.5 cm to 3.0 cm diameter are common. The quartz pebbles are moderately sorted and well packed. Gold in the ore ranges from 0.78 - 3.86 g/t such that high-grade ores had glassy quartz pebbles whiles medium to low-grade ores had sugary varieties. Gold recovery (38.66 - 95.08%), generally increased with increase in the percentage of the matrix volume. It is also higher in ore containing gray quartz and containing much ore minerals; lowest recoveries have high quartz, low matrix volume, and rich in quartz. Also, associated with lower recovery was higher chlorite content which may require more metallurgical treatment for efficient recovery.

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The conglomerate ore is white to dark gray with patches of brown or gray. It is laminated with current bedding (e.g. B3, C1). Pebbles are very coarse-grained of glassy quartz, made up of subrounded to well rounded, moderately sorted to poorly sorted, and poorly packed (e.g. B1, B3, C1) (Fig. 2). The rock fragments are sheared, occupied by chlorite, foliated and contain opaque minerals. Elsewhere, dark gray pebble (greywacke) is composed of quartz, plagioclase, amphibole, and opaque minerals (B1 and B2). Gray quartz is sheared into milky varieties (A1). There is recrystallized quartz aggregate with preserved primary texture along bedding planes, interlaminated with hematite (Fig. 4). Fractures found in glassy pebble varieties which are non-sheared but pushed and offset bedding planes (B3). Elsewhere, sheared and elongated quartz pebble is recrystallized, elongated and caught up in a shear zone marked by magnetite-rich layers (B3). Sample from Pepe pit (C2) contains sericite along sheared zones within the matrix and at the margins of the quartz pebbles. The medium-grained recrystallized quartz pebbles are weakly sheared, sugary and elongated (C2) (Fig. 5). Though sample C1 which indicates primary alternation of fine to medium-grained sugary quartz, spotted with hematite and inter-bedded with hematite in millimeter scale bands (Fig. 3), it occasionally shows current bedding. Some glassy quartz were fractured, stained along fractures by ore minerals (C3). The quartz fragments were recrystallized into sugary textures (B1 and B2) just as some quartz-rich bands in laminated variety form veins across hematite-rich layers or are recrystallized. Quartz pebbles when recrystallized are glassy, milky and also fractured (C2). Closely packed quartz is rarely elongated, with quartz veinlets parallel to shear (C3). Gray quartz in the matrix is medium grained and dusty with fine-grained ore minerals (B1 and B2) and cut by quartz veinlets (C3). Moderately sheared quartz is drawn out into augen textures or recrystallized into sugary varieties with triple junctions (C3); a few quartz is caught up in rare shear zone (C1).

The pebbles are generally held together by a dark gray matrix which is medium-grained. Sericite along shear zones within the matrix made up coarse to medium-grained quartz with smaller quartz pebbles, elongated and sutured at the margins (C2). The modal percentage of the conglomerates is difficult to determine as the pebbles could be up to cobble size. The modal percentage of minerals in the matrix of the various conglomerate samples shows quartz (pebbles and the matrix determined in thin section) ranges from 60-90%, plagioclase up to 5%, chlorite 2-30%, sericite is up to 3%, ore minerals 2-30% (Table 2). Table 3 and Figure 6 show modal percentage of total quartz including quartz in matrix together with gold recovery and grades.

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Table 1. Divisions of the Tarkwaian [19].

<table>
<thead>
<tr>
<th>Group</th>
<th>Series</th>
<th>Thickness (m)</th>
<th>Composite Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tarkwaian</td>
<td>Huni Sandstone (and Dompim Phyllites)</td>
<td>1370</td>
<td>Sandstones, grits and quartzites with bands of phyllites.</td>
</tr>
<tr>
<td></td>
<td>Tarkwa Phyllites</td>
<td>120 – 400</td>
<td>Huni sandstone transitional beds; green and greenish gray chloritic and sericitic phyllites and schists.</td>
</tr>
<tr>
<td></td>
<td>Banket Series</td>
<td>120 – 160</td>
<td>Tarkwa phyllites transitional beds and sandstones, quartzites, grits, breccia and conglomerates.</td>
</tr>
<tr>
<td></td>
<td>Kawere Group</td>
<td>250 – 700</td>
<td>Quartzites, grits, phyllites and conglomerates.</td>
</tr>
</tbody>
</table>

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Fig. 1. Simplified Geological Map of the Study Area [19].
Fig. 2. Photograph of Conglomerate from Efuant B1 (A, B) showing Glassy Quartz Pebbles.

Fig. 3. Photograph of Conglomerate (Sample C1) showing Sugary Quartz Pebble.

Fig. 4. Photograph of Conglomerate sample C2 (A, B) showing Glassy Quartz partially recrystallized.

Fig. 5. Photomicrograph of Conglomerate from sample C2 under Cross Polarized Light showing (A) Recrystallized Quartz, and (B) A Cluster of Granular Ore minerals.
The Tarkwaian Banket conglomerate ore contains 60-90% quartz made up of pebbles and matrix. The matrix is composed of fine to medium and some coarse-grained quartz, with minor sericite, and chlorite. Ore minerals include pyrite, hematite, magnetite, ilmenite, rutile and zircon [4, 14, 7]. The pebbles are sub-rounded to rounded, with about 0.5 cm to 3.0 cm diameter, coarse-grained, moderately sorted and well packed. The pebbles are glassy, milky and have been partially recrystallized into sugary varieties. Fractured, white, smoky, bluish or gray quartz veins at the Obuasi mine in the Birimian Supergroup are generally richer in microscopic gold inclusions [21]. The gray quartz in the Tarkwaian, however, are not primary pebbles but formed during recrystallization. The conglomerate contains high quartz (90%) or moderate quartz (60%) of which the higher quartz conglomerates could also contain higher matrix volumes (>40%) or lower to moderate matrix (10-20%) (Table 3, Fig. 6). Gold grade ranges between 0.78 - 3.86 g/t of which higher grade ores contain glassy quartz pebbles, whilst medium to low grade ores are associated with sugary varieties. Gold recovery range from 38.66 - 95.08%, and generally increase with increase in the percentage of the matrix, e.g. samples B3, C1, and C3. The recovery, however, rarely decrease with increase in quartz composition e.g. sample C3 (Table 3). Hence generally high recoveries (80-90%) conform to moderate quartz percentage (60-80%) and variable matrix volumes (10-40%) while lowest recoveries have high quartz (90%) and low matrix (10%); example samples A1, A2, B1, B2. Sample C2 with lowest gold recovery of 36.66% contains high quartz (90%) with moderate matrix (40%) and so the matrix is also rich in quartz grains. This turned out low recovery of 38.66% (Table 3, Fig. 6). Therefore the recovery of gold from the Tarkwaian matrix is paramount and dependent on the volume of matrix and it is adversely affected by higher modal percentage of quartz composition. Free gold sizes in the Tarkwaian Banket conglomerate range between 0.002 mm and 0.500 mm and related to the size of gold, the size and packing of the quartz pebbles [14]. There is increasing diameter of larger quartz grains in the matrix which conforms to increase in gold grade [22]. Increase reagent consumption rate is associated with ores with more chlorite and much iron oxide minerals in the matrix [18]. Ores containing gray quartz (samples A1, and A2) and higher ore mineral composition (samples B3, C1) generally have higher recovery (Table 2).

The presence of hematite significantly reduced the dissolution of gold as hematite formed coatings on gold surfaces to prevent leaching [23]. The B3 and C1 samples which contain high ore minerals may, therefore, comprise less hematite in favor of magnetite [4, 14, 7]. Lower recovery of sample B1 also has highest chlorite content (30%) (Tables 2 and 3). Therefore conglomerate ores with high chlorite content may require higher roasting temperature and more reagent consumption for efficient recovery. Ore separation for special treatment is therefore recommended.

**Conclusions**

The Tarkwaian Banket conglomerate ores contain 60-90% quartz, in both pebbles and matrix. The pebbles are sub-rounded to rounded, with about 0.5 cm to 3.0 cm diameter, coarse-grained, moderately sorted and well packed.
The pebbles are glassy, milky and partially recrystallized into sugary varieties. The matrix is composed of fine coarse-grained quartz, with minor pyrite, hematite, sericite, and chlorite. Gold grade ranges between 0.78 - 3.86 g/t. High-grade ores have glassy quartz pebbles whiles medium to low-grade ores have sugary varieties. Gold recovery ranged from 38.66 - 95.08% and generally increased with increase in the percentage of the matrix volume. Higher gold recoveries conform to moderate quartz percentage (60- 80%) and variable matrix volumes (10-40%) while lowest recoveries have high quartz, low matrix volume but with the matrix richer in quartz. The ores containing higher gray quartz and higher ore minerals generally have higher recovery; while lower recovery associated with the ore with higher chlorite content which may require more reagent consumption for efficient gold recovery.

Acknowledgement

Professor Richard K. Amankwah provided guidance at the Minerals Engineering laboratory, University of Mines and Technology.

References


