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RESEARCH ARTICLE

# CHARACTERIZATION OF GOLD DEPOSITS OF THE HAMBOL REGION (IVORY COAST)

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A B S T R A C T

The aim of our study was to characterize the gold deposits found in the Hambol region. SRTM and Landsat images have summers used in this study, through specific treatments. Image processing techniques, the algorithm LDS and calculating the roughness index helped to understand the geology and tectonics of the region Hambol. The lower altitudes and areas and other geological formations such as quartz and hydrothermal alteration rocks were correctly identified. All these results enabled us to offer gold concentration areas and guidance for prospectors.



## INTRODUCTION

Knowledge of the basement is a growing concern. This requires a good knowledge of geology. Several techniques have been developed to better locate underground natural resources. The current state of knowledge about gold deposits of the Hambol region remains superficial compared to the level of knowledge of lodgings worldwide. One of the main obstacles to mining exploration remains the lack of geological information (lithology, structure, etc.). This is in order to contribute to the development of new geological knowledge in that part of Côte d'Ivoire that this work was initiated.The study of the geology of the region Hambol was conducted by several researchers, but without a link with deposits. Hambol the region lies at the heart of Man backbone and consists of a variety of Birimian formations. The main ones are: granitoids, meta-volcanic (basalt, andesite), greenstone, and meta-sediments (Doumbia, 1997).

The studyof geological formationsis important insectors such asmining.An important partof the economydepends significantly onthe valuation ofsubsoilresources.Knowledge of thegeology would facilitatemining explorationin that itholdsa share of moreand more importantin GDP (Gross Domestic Product) in many countries.

To facilitate mineral prospecting requires a good knowledge of the geology of the Ivory Coast particularly that of Hambol region that is already producing some minerals such as diamonds and gold. The approach to development by the exploitation of mineral resources is justified from the economic point of view because they are a natural capital whose extraction produces wealth that can be consumed or invested in the production of other capital (Murphy *et al*. 1989; Sachs, 1999; World Bank, 1992).

For these reasons, the mineral resource is an opportunity for countries which have it. Include several countries such as Australia, Norway and Botswana, which have benefited for their development (Davis and Tilton, 2002; Labonne, 2002). This study it isto characterize the gold deposit sand identify areas of these minerals. To achieve this goal, a number of specific objectives has been set: -Make petrographic analysis by describing the different types of rocks Hambolregion; -Make analysis of tectonics tructures from sate llite image processing type SRTM, Land satand field data; -Make aninterpretation of the factorsat the origin ofgold depositsin the regionto establishthe characteristics ofdeposits.

### *Study area*

Hambol region is about 400 km from Abidjan (the economic capital of the Ivory Coast) and one hundred and forty kilometers from Yamoussoukro (political capital). It is located in UTM zone 30 north, longitude between 200 000 meters and 400,000 meters East and latitude 862,000 meters and 1 050 000 meters North. Regional mapping performed according to morpho-pedological approach showed that soil evolution of Katiola department depends on the following soil processes: induration or armoring, realignment, pédoplasmation, alteration, loss and waterlogging.

This is a very monotonous plateau region with an average altitude is slightly greater than 300 meters with a slight dip to the southeast in the Katiola region where the altitude is about 250 meters. The reliefs are here essentially remains of laterite. In northeastern Niakaramandougou emerges Mount Niangbo which rises to 694m and south of Mount Dabakala department Nagbion which rises to 610 m. Lower center, towards the Northeast, there remains a line of hills with an average altitude of 400 m (GEOMINES 1982). The rocks of the region are formed almost entirely of base rock, crystal and cristallophyllienne. The rocks of the region are dominated by granites (granitoid) and schist (undifferentiated shales, schists Grauwackeux) these two groups constitute 90% of the rocks in the area.

In general, the vegetation encountered is the savanna, but in some places there is grassland dotted with galleries forests. Most of the Hambol region is subject to the Sudanese climate, transition tropical regime between sub-Saharan semi-arid and tropical wetlands of the Gulf of Guinea, with maximum rainfall in July, August and September and drought in December, January and February (Coulibaly, 2009). Hambol region is drained by three major rivers and their tributaries are the Bandama in the west to the Marabadiassa, N'Zi center and Comoé in the East. Geologically, the area is in the heart of the back of Leo and the geological formations of the region belong to Hambol Birimian or Paleoproterozoic (Doumbia, 1997).

## MATERIAL AND METHODS

## MATERIAL

We used two types of satellite images. SRTM images that are elevation data and Landsat 8 of eleven spectral bands, a panchromatic band, eight multispectral bands and two bands Infrared Thermal.Data mining are the coordinates of the different types of minerals already found in Hambol region. They come from the Ministry of Mines and Energy. We also have geological and hydrographic maps that serve as a baseline for the interpretation of satellite images. We worked with Geographic Information Software (LIG): such as Quantum Gis for treatment, produce different results.

## METHODS

### *Processing*

The treatment consisted in mosaicking, vectorization, the enhancement of the data, the application of Line Segment Detection algorithm (LDS), the calculation of the terrain roughness index and the different band combinations of Landsat image.

### *Topographical study*

### *Calculating the ground roughness index*

The topography Roughness Index (IRT) or Topographic Ruggedness Index (TRI) is a measure of the average value of the difference in elevation between adjacent topographical measurements in a digital elevation model (Riley *et al.*, 1999).

$$TRI = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(x_i - x_{i-1}\right)^2} .$$

Here, Nis the total numberoftopographical measurements, xiisthe ithtopographicprofile measurement, andxi+1 is thetopographicmeasurementxineighbor.

### *Processing of Landsat imagery*

## RESULTS

### *Tectonic features of deposits*

Table below shows a summary of the structural features of the region. The lineament network is predominantly oriented along the NE-SW direction with a rate of 29%. This NE-SW direction is the Birimian tectonic direction. The Birimian formations are geological formations that contain gold in West Africa. As for the East-West direction, it has a rate of 31%. In general, the lineaments blend with the brittle tectonics of the Ivory Coast. 19% of lineaments are oriented north west southeast corresponding to the Leone direction figure 3.

**Table I** Nombre *ET* Longueur Totale De Linéament Par Direction

| Direction d' extraction | Nombre de linéaments | Longueurs en km | Longueur Moy. En Km | Orientation maximum | |
|---|---|---|---|---|---|
| Est-Ouest | 7 169 | 36 728 | 5.123 | 0°- 10° | 7.73% |
| Nord-Sud | 4 874 | 24 131 | 4.950 | 0°- 10° | 7.09% |
| Nord-Ouest Sud-Est | 4 411 | 21 632 | 4.904 | 160°-170° | 7.16% |
| Nord-Est Sud-Ouest | 6 691 | 33 864 | 5.061 | 170°- 180° | 5,43% |
| Toutes les directions | 23 145 | 116 355 | 5 | 0°-10° | 7,04% |

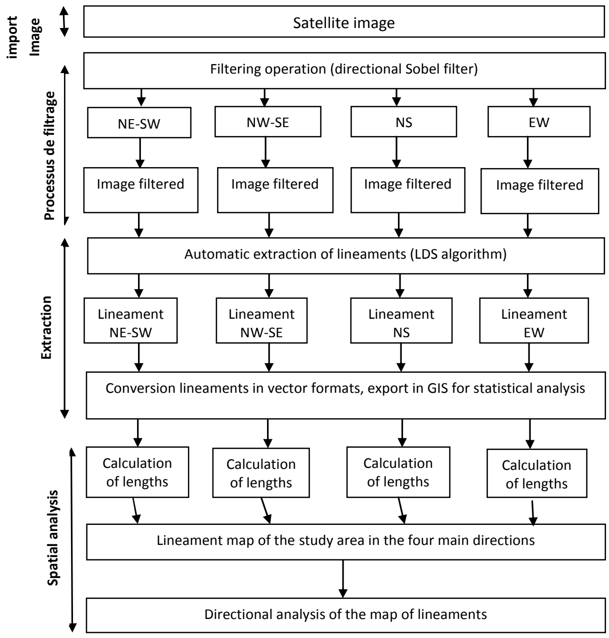


**Figure1** Automatic extraction pattern lineaments

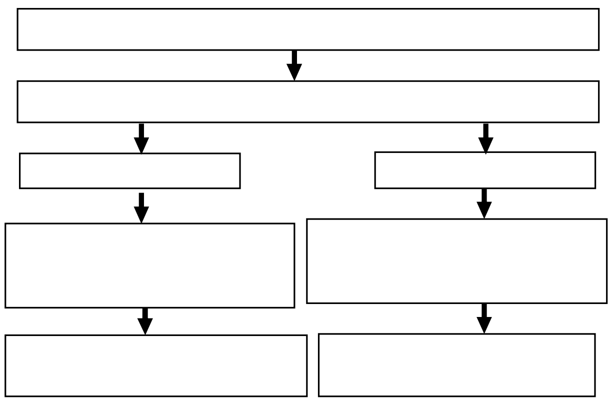

**Figure 2** Diagramme du traitement des images Landsat

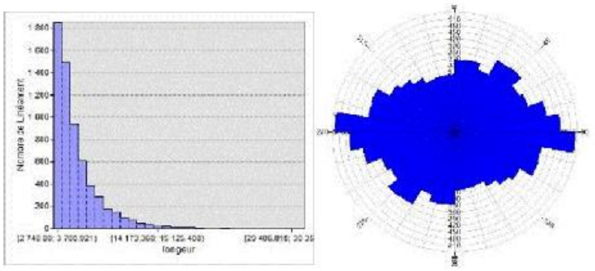

**Figure 3** Histogram and directional rosettes lineaments

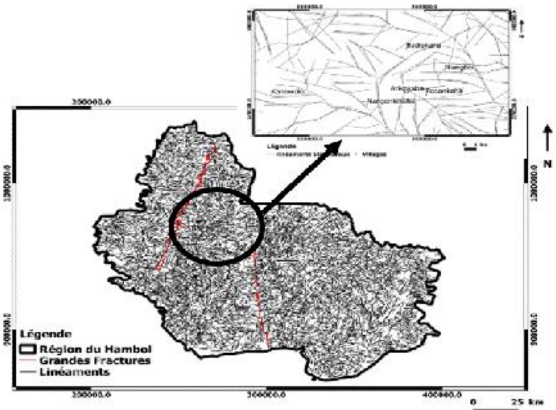


**Figure 4** structural lineamentsof the study area

The observation and analysis of the map of lineaments obtained allows us to distinguish two great major fractures. The first is long 95 km NE-SW direction corresponds to the direction of the major tectonic region. This fracture is from the Northwest area Kourokouna to Eastern Kafiné.

It crosses the sub-prefectures of Tafire-Niakaramandougou and has coordinates 238,205 meters and 267,578 meters East and 938,538 meters and 1,021,864 meters North UTM Zone 30 North. The second major fracture extends in the direction N-S separates the departments of Katiola and Dabakala. It cuts the area into two almost equal parts. This second fracture is long 100 km. It starts from the eastern town of Koulokaha to southern department of Katiola in the west of the village of Toumboho. It crosses the sub-prefectures of Foumbolo, Boniérédougou and Timbe. Its coordinates 292,052 and 300,894 meters East and 889,166 meters meters meters North and 985,013; UTM Zone 30 North (Figure 4). The structural features achieved in this study are mainly oriented in the east-west and north-east directions southwest latter is the preferred direction of formations according Birimian (Tagini, 1971). This shows that the region has been affected mainly by the Eburnean orogenic cycle and secondarily by the Leone cycle.

In the base areas, as is the case in our study area, streams and terrain bear the imprint of the regional tectonics (Horton 1945; Biémi 1992). The main rivers settle mostly in major fractures of the Precambrian basement (Biémi *et al*. 1991). Our results compared with the map of temporary and permanent rivers shows that the majority of rivers are influenced by geological structures, including fracturing.

### *Characterization of the deposits by the roughness index*

The analysis of the terrain roughness index show that the low index areas are low-lying areas with gentle slopes and relatively flat lands conducive to deposition of sediment or gold nuggets (Figure 5). Our results corroborate with the work of Riley *et al*., 1999 which established the principle of calculating the ground roughness index. The calculation of roughness index reveals that much of the territory at an index less than 10; the area is relatively flat with gentle slopes. The index value corresponding to the concentration of gold in alluvial zones is 3.58. This value corresponds to areas of lower altitudes. These potential areas of concentration are framed with black rectangles (Figure 5).

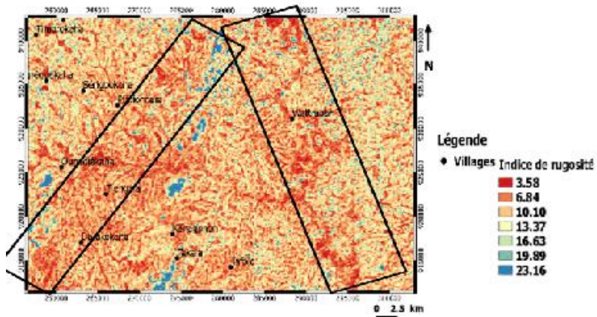


**Figure 5** roughness indices map of Hambol région

### *Characterization of deposits by color composition in RGB 2-4-7*

The gold deposits of Hambol region are hosted by volcano-sedimentary rocks or detritus. The study area was structured by the Birimian orogeny (2400-1500) which resulted in geological formations oriented NE-SW. Gold alluvial deposits are located in the regolith, the sands along rivers and shorelines. The color composite RGB 247 of Landsat image allows us to locate the deposits that may be of alluvial gold deposits. Figure 6 shows as yellow line these areas deposits.

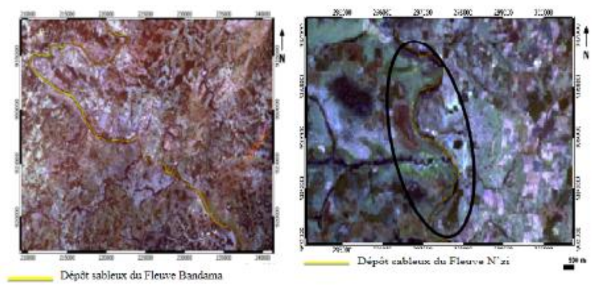


**Figure 6** Dépôts Sableux du lit des Fleuves Bandama et N'zi

### *Characterizations of deposits by colored composition 4 / 2-6 / 7-5 RGB*

The hydrothermal alteration zones are rare in the region. The hydrothermal alteration zones are potential cottages concentration of lode gold. The few hydrothermal areas that we found is always superimposed on a lineament Figure 7.

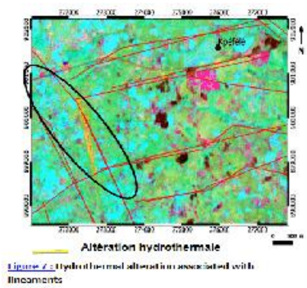


**Figure 7**

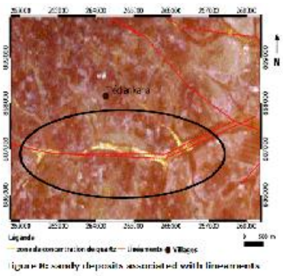

**Figure 8**

Figure 8 shows that sand deposits are correlated with the lineaments. This correlation shows that the deposit areas detected by the color composite images are located on Land Sat lineaments. Note that the lineaments which are areas of excellence by discontinuities are also home to chemical weathering phenomenon, physical alteration and deposits of regolith.

The gold deposits in the region are very Hambol alluvial often they result from the weathering of host rocks which are easily degradable clastic rocks. This explains the fact that he has a lot of alluvial deposits in the region. The majorities of deposits found in the area are close to the river and are located in the lowest point of the relief in the Birimian formations. Several sandy deposit boxes were found in the beds of N'zi River and the Bandama river. Our results corroborate those of Escadafal R. *et al*., 1989. The visual interpretation, allowed us to identify areas of sand formation of deposits 9 and Figure 10.

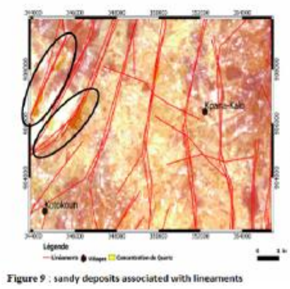


Figure 9

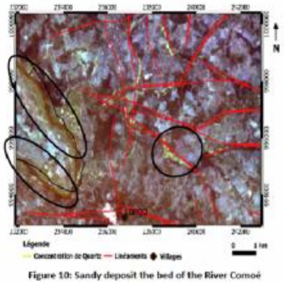


Figure 10

## CONCLUSION

The study of the characterization of gold deposits has allowed us to make the following observations:

- ✓ The main types of gold mineralization in the area are mainly composed of alluvial placers and some of vein deposits.
- ✓ More than half of the rocks in the region are Birimian. This type of rock is the intense mineralization seat, and should be explored as a priority.
- ✓ The region has been affected largely by the orogeny since Birimian structural lineaments in the region are mostly from northeast direction and Southwest.
- ✓ The study of the topography through the calculation of the terrain roughness index was used to extract the low areas of terrain likely to accumulate sediment and gold ores. Note that the gold deposits already discovered in the area are for the most part located in areas of low roughness index close to rivers.
- ✓ The hydrothermal alteration zones overlap with structural lineaments. Sand deposition zones overlap with structural lineaments. These overlay areas are potential sites quartz vein that could contain lode gold.

## Bibliographical References


1. Banque Mondiale. 1992. Strategy for African Mining. Rapport technique; No 181; 102 p.
2. BIÉMI J. 1992. Contribution à l'étude géologique, hydrogéologique et par télédétection des bassins versants subsahéliens du socle précambrien d'Afrique de l'Ouest: Hydro structurale, hydrodynamique, hydrochimie et isotopie des aquifères discontinus de sillons et aires granitiques de la haute Marahoué (Côte d'Ivoire). Thèse de Doctorat d'État, Univ. Nationale de Côte d'Ivoire, 450 p.
3. BIEMI, J., GWYN, Q.H.J., DESLANDES, S. et JOURDA, P. 1991. Géologie et réseaux de linéaments régionaux du bassin versant de la Marahoué, Côte d'Ivoire: cartographie à l'aide des données Landsat TM et du champ magnétique total. Télédétection et gestion des ressources, 7 :135-145.
4. COULIBALY T. J. H., 2009. Répartition spatiale, Gestion et Exploitation des eaux souterraines Cas du département de Katiola, région des savanes de Côte d'Ivoire Thèse de 3ème cycle, Université Paris Est, 141 p.
5. DAVIS, G and TILTON, J. 2002.Should developing countries renounce mining? A perspective on the debate. Extractive industries review: 40p.
6. DEROIN J.P. 1992.Méthodologie d'utilisation de l'imagerie satellitaire à haute résolution spatiale en zone tempérée.BRGM, 208 p.
7. DOUMBIA S., 1997. Géochimie, géochronologie et géologie structurale des formations birimiennes de la région de Katiola-Marabadiassa (centre-nord de la Côte-d'Ivoire).Thèse doc.Univ. Orléans, 214 p.
8. ESCADAFAL R. et POUGET J., 1989.Comparaison des données Landsat MSS et TMpour la cartographie des formations superficielles en zone aride (Tunisie méridionale).Atelier de Télédétection, Centre ORSTOM, Bondy, France: 301-307.
9. GEOMINES 1982. Inventaire hydrogéologique appliqué à l'hydraulique villageoise. Ministère des travaux publics et des transports. Direction centrale de l'hydraulique, république de Côte d'Ivoire, Carte de Katiola, Cahier n° 11, 24 pp.
10. HORTON R.E. 1945. Erosional development of streams and their drainage basins: hydrophysical approach to quantitative morphology. Bulletin of the Geological Society of America, 56: 275-370.
11. LABONNE, B. 2002.Commentary: Harnessing mining for poverty reduction, especially in Africa. Natural Resources Forum, No 26: 69-73.
12. MURPHY, K. ET COLLEGUES. 1989. Industrialization and the big push. *Journal of Political Economy* 97 (5):1003-1026
13. POUR A., HASHIM M., 2014.Hydrothermal alteration mapping from Landsat-8 data, Sar Cheshmeh copper mining district, south-eastern Islamic Republic of Iran. *Journal of Taibah University for Science*. 9 (2015):155–166.
14. RILEY S. J., DEGLORIA S.D., AND ELLIOT R., 1999. A terrain ruggedness index that quantifies topographic heterogeneity: Intermountain *Journal of Sciences*, v. 5, no. 1–4, p. 23–27.

15. SACHS, J. 1999. The big push, natural resource booms and growth. *Journal of development economics*. 1(59): pp. 43-76.
16. TAGINI B., 1971. Esquisse structurale de la Côte d'Ivoire. Essai de géotectonique régionale. Thèse, Univ. Lausanne, SODEMI, Abidjan, Côte d'Ivoire, 5, 302 p.

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