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STRUCTURE OF THE GOLD-BEARING KIBARIAN DISTRICT OF NYUNGWE (SOUTHWEST RWANDA) - IMPLICATIONS FOR BURUNDIAN STRATIGRAPHY[1]

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(7 figures and 1 table)

RESUME.- L'interprétation des données nouvelles, acquises dans le cadre de la prospection minière du PNUD entre 1977 et 1982 et le traitement statistique des données structurales du secteur Nyungwe, aboutit à une esquisse structurale de ce secteur aurifère.

Trois phases de déformation majeures sont mises en évidence:

- une première phase produit la schistosité de flux S_1, subparallèle à S_0. Aucune charnière de plis correspondant à cette phase n'est observée;
- une seconde phase de déformation en plis cylindriques déversés vers le sud-ouest et évoluant en plis faillés chevauchants induit le clivage de fracture S_2, oblique et omniprésent;
- une troisième phase de fracturation et cisaillement tardifs produit un réseau de failles et diaclases N5°-N50°E et une schistosité de fractures, qui, localement, est en plan axial de «kink folds» de S_2, à axes subverticaux. Un magmatisme basique est associé à des fractures d'extension contemporaines de la phase 3, tandis que certains filons aurifères paraissent liés aux dernières manifestations de la phase 2.

Une colonne stratigraphique à valeur locale est proposée; elle comprend 7 unités lithologiques de bas en haut: quartzites à magnétite, schistes microrubanés, métavolcanites dacitiques à pyrite, schistes gris à fins bancs de quartzites, schistes gris à gros bancs de quartzites en séquences de type turbidite, quartzo-phyllades noires et schistes violacés.

L'étude pétrographique confirme l'hypothèse antérieure d'une origine volcano-sédimentaire d'une partie des chloritoschistes pyriteux de la Nyungwe amont. L'analyse confirme le chimisme métadacitique potassique de laves amygdalaires intercalées dans ces faciès.

Le rôle métallogénique de cet épisode volcanique dans la mise en place d'une préconcentration aurifère d'extension régionale au sein des formations burundiennes fera l'objet d'études complémentaires.

ABSTRACT.- The structure of the gold-bearing district was derived by interpretation of new data acquired in the framework of gold exploration of UNDP between 1977 and 1982, and the statistical processing of Nyungwe area structural data. Three main deformation phases were identified:

- The first phase produced S_1 flow cleavage subparallel to S_0. No fold hinges from this phase have been observed.
- A second phase of cylindrical folds overturned to the southwest, evolving to overthrust inducing intersecting S_2 fracture cleavage throughout.

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- A third phase of fracturing and late shearing produced a N50°E trending fault and joint system, and fracture cleavage, which locally is the axial plane of S_2 kink folds, with subvertical axes. Mafic volcanic rocks are associated with late phase 3 extensional fractures, and some gold-bearing veins seem late phase 2.

A stratigraphic column of local value is proposed, which comprises seven lithological units, from bottom to top: magnetite-bearing quartzite, variegated schist, pyritic dacite metavolcanics, turbidite-like sequences of grey schist with thin bedded quartzite evolving to thick-bedded, black slate, and purple schist.

Petrographic studies confirm the previous hypothesis of a volcanosedimentary origin for part of the pyritic chlorite schist of the upper Nyungwe. Analysis confirms the potassic metadacite chemistry of amygdaloidal lava intercalations in this facies.

Around the lake Kivu area, the location of the main gold placers related to the Kibarian pyritic metavolcanic belts suggests a volcanogenic origin for at least part of the primary stratabound gold mineralization.

INTRODUCTION

This paper presents field data collected over three years of exploration for primary sources of the alluvial gold deposits known in the Nyungwe Forest since 1936. The data, published as UNDP[1] internal reports (Salpeteur, 1979) only integrate part of the field observations. Checking by trenching and drilling of the main gold anomalies identified by a 1980 preliminary geochemical exploration programme, opened new areas for exploration, and new analogies appeared between predominantly argillaceous rocks of different appearance. The work confirmed the economic potential of the Cyurugeyo gold-bearing stockwerk which was evaluated by the UNDP revolving fund in 1985-1988.

To understand better the origin of the mineralisation, the old data have been processed by computer, and compared with the more recent work carried out by teams from the Ministry of Mines, Belgian Cooperation (MRAC) and UNESCO's IGCP Project 255. Financial aid given by the BRGM Scientific Direction enabled chemical and petrographic analysis of some facies for a more accurate diagnosis of the origin of rocks which have the primary characteristics oblitered by metamorphism.

The area studied is occupied by low metamorphic grade rocks, which have been attributed to the lower Burundian by recent work (Buyagu and Trefois, 1983) in the Nyungwe Forest which covers the western part of Rwanda. The area mapped in detail is bounded to the northeast by the drainage divide between the Nyabugonde and Nyungwe basins, to the southeast by the Nyungwe-Tangaro ridge, and to the northwest by the Kamiranzovu swamp (Fig.1).

More than 700 structural measurements taken between 1977 and 1981 have been computer processed. The section of the road surveyed at a scale of 1:500 in 1979 has be re-interpreted by integrating Schmidt diagrams and trench surveys. The accurate identification of some facies by microscope, and multi-element chemical analysis methods not available at the time, also contributed to the re-interpretation.

1.- STRUCTURAL STUDY

During the gold exploration survey made within the UNDP framework in the Nyungwe Forest, a map of the upper Nyungwe area was complied at a scale of 1:50,000 (Fig.2) in collaboration with T. Rwagashaija and E. Bizimana, geologists on the UNDP Mining Research Project. The survey was made using cuttings along the Butare-Cyangugu road (surveyed at a scale of 1:500), detailed surveys of old Minetain trenches and new exploration trenches on the main gold geochemical anomalies (made in 1980-81) and of stream beds scoured by gold miners.

The new track for taking the drilling rig to the Cyurugeyo vein area, and cored drill holes on this site allowed interpretation of the structure in the northeast part of the study area (Fig.2) which is particularly complex.

STRUCTURE OF THE SECTION OF THE BUTARE-CYANGUGU ROAD BETWEEN UWINCKA AND KAMIRANZOVU (Fig.3).

The structure of the sedimentary rocks with quartzite intercalations (bedding markers, common way up criteria) is not difficult to interpret; however that of the predominantly schistose rocks (overturned limbs, normal limbs) is more difficult:

1 United Nations Development Program

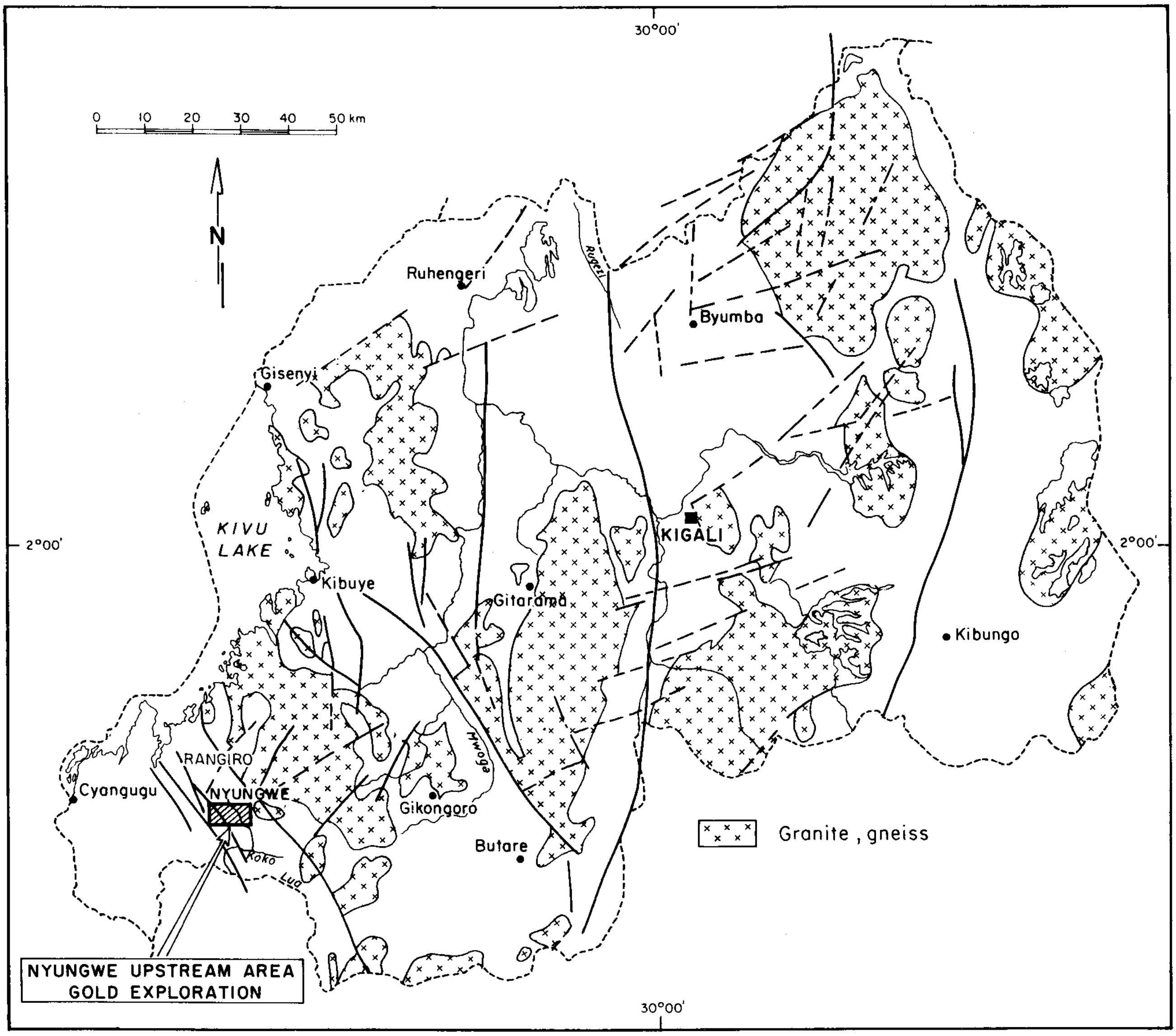

Fig. 1.- Location of the upper Nyungwe area.

(1) The grey, pink and purple banding in the schist produced by weathering reflects the variations in the initial composition of rocks, i.e. the sedimentary layering S_0.

(2) The S_1 cleavage, subparallel to S_0, is a flow cleavage of much debated origin [burial schistosity, or cleavage associated with early shearing of regional extension, as suggested by the work of Klerkx and Theunissen (1980) in Burundi, and that of Blès (1972) and Rumvegeri (1984) in Kivu].

(3) The S_2 cleavage is a fracture cleavage which intersects S_0/S_1 banding. Locally, recrystallized sericite and quartz grains oriented parallel to S_2 indicate an increase in metamorphic grade.

(4) The S_3 cleavage intersects the S_2, and is a fracture cleavage which corresponds to the axial plane of the kink folds associated with sinistral strike-slip faults. The S_0-S_1/S_2 relationships and the various way-up criteria (graded bedding, scour and fill, cross stratification and ripple-marks) particularly common in schist-quartzite layers (units C and D on section Fig.3) which surround the central schist area, have enabled identification of the phase 2 anticlinal and synclinal structures.

2.- BRIEF DESCRIPTION OF FACIES AND LITHOLOGY

From southwest to northeast of the study area (Fig.2 and 3) are:

(1) Quartzite: grey-white (unit F), thick bedded quartzite, fine grained 0.3 to 2 m-thick layers, cross stratified, interbedded with light-grey

schist. The layered quartzite is cut by three joint systems. The quartzite forms a drainage divide between the Nyungwe and Tangaro basins. Locally, it is rich in octahedral magnetite, and cut by pyrite and green-tourmaline-bearing quartz veins.

(2) Blanded variegated schist (unit F') about 200 m thick, conformably overlies the quartzite. The banding is defined by centimetre-thick alternation of light silty layers and pink or purple phyllite layers. Towards the northeast, the schist is intruded by a brick-red mafic sill.

(3) Orthoamphibolite sill (unit G) weathered to brick-red iron-oxides, quartz, residual muscovite, about 150 m thick. A less weathered sample of the rock taken above G9 (Fig.2), south of the road, confirms the following mineralogy characteristic of an orthoamphibolite: iron-rich hornblende, biotite, quartz micropegmatite and plagioclase (andesine) altered to epidote, and secondary albite. The rock contains tourmaline, iron oxides and rutile. The massive, unfoliated rock has intruded the schist which is contact-metamorphosed: silicification, marked bleaching over a width of more than a metre, tourmaline-bearing veins more dense near the contact, recrystallisation of sulfides (pyrrhotite, pyrite) disseminated in chlorite-schist country rock to the northeast. Octahedral pyrite is particularly abundant above G9 (according to the ancient unpublished topographic map of the Minetain Company, 1936).

(4) Quartzite phyllite, greenish, with sulfide nodules (unit E). The rock consists of a fine mosaic of quartz, chlorite and abundant sulfides (2-3%). The biotite, partially chloritised, is oriented parallel to S_2. The late biotite crystallisation can be related to the contact metamorphism near the orthoamphibolite sill which was intruded at the end of phase 2. The rock is cut by many quartz, chlorite and sulfide veinlets.

(5) Schist, pinkish-grey, with thin bedded rusty quartzite (unit D) lacally cross-stratified. The

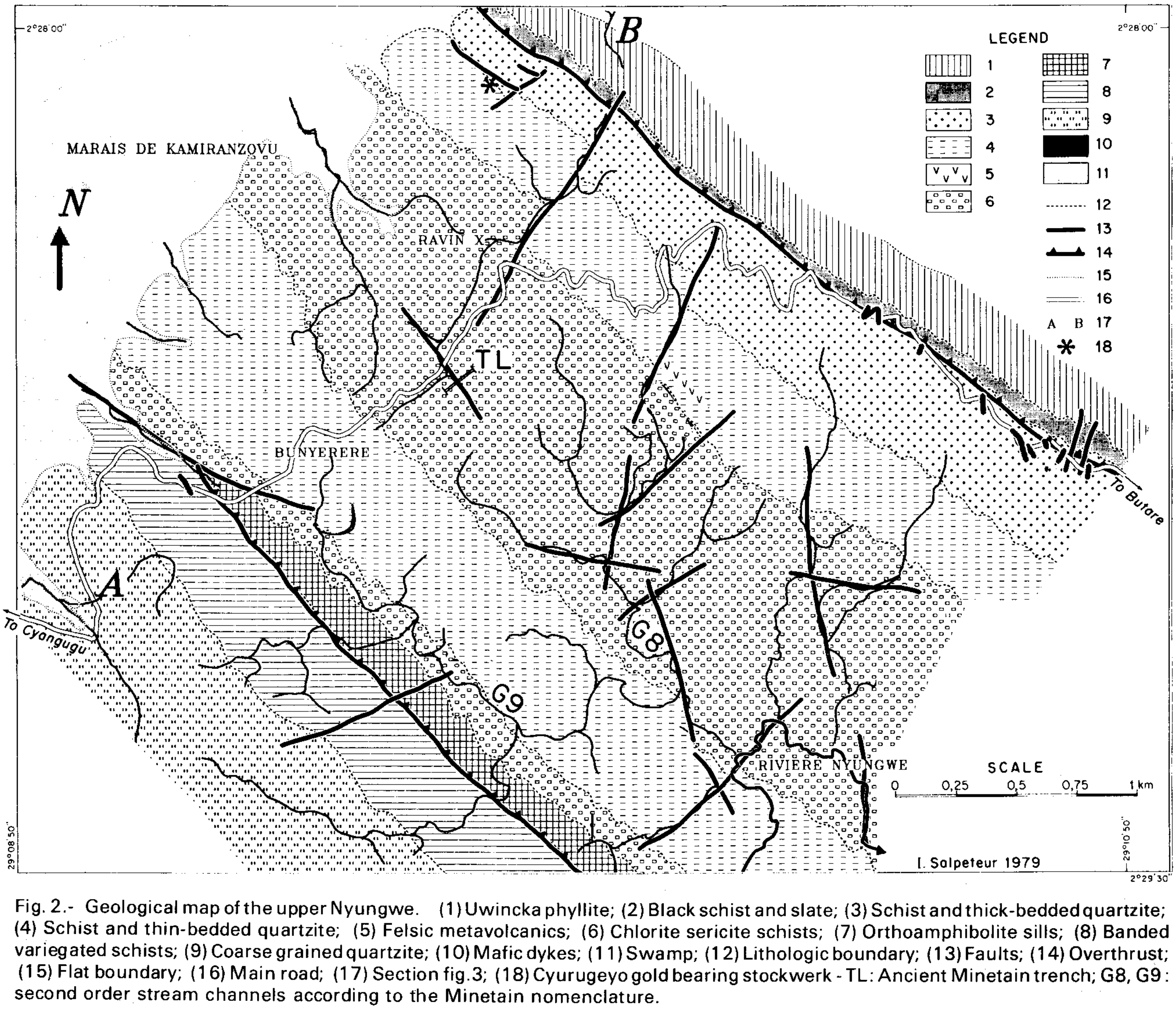

Fig. 2.- Geological map of the upper Nyungwe. (1) Uwincka phyllite; (2) Black schist and slate; (3) Schist and thick-bedded quartzite; (4) Schist and thin-bedded quartzite; (5) Felsic metavolcanics; (6) Chlorite sericite schists; (7) Orthoamphibolite sills; (8) Banded variegated schists; (9) Coarse grained quartzite; (10) Mafic dykes; (11) Swamp; (12) Lithologic boundary; (13) Faults; (14) Overthrust; (15) Flat boundary; (16) Main road; (17) Section fig.3; (18) Cyurugeyo gold bearing stockwerk - TL: Ancient Minetain trench; G8, G9: second order stream channels according to the Minetain nomenclature.

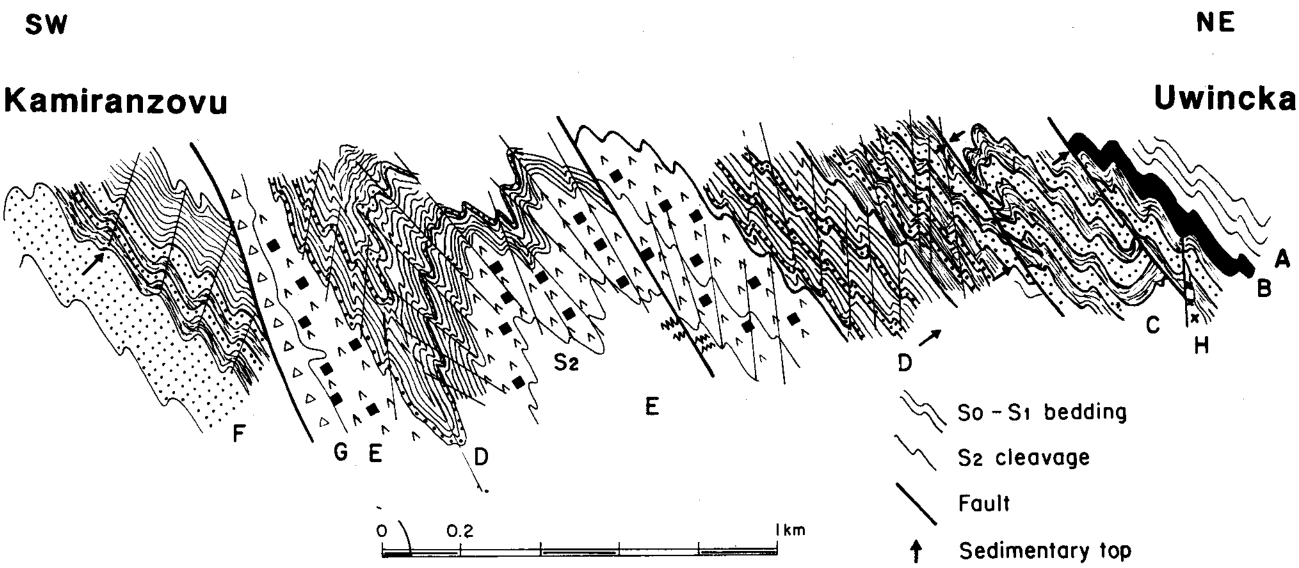

Fig. 3.- Section showing the structure along the Butare-Cyangugu road.

layers are about 1-3 cm thick, and conformably overlie the phyllite. Study of the S_0/S_2 relationships shows that the structure is a syncline (Fig.3).

(6) Pyritic chlorite schist, similar to unit E, but less metamorphosed, and light coloured with disseminated fine pyrite (1-5 mm). Oxidised pyrite crystals leave iron-oxide-filled cavities and give the rock its characteristic rusty colour. The variations in the dip of S_2 show that the rock is the core of a faulted anticline (Fig.3) cut by many pyritic quartz veins. Near the marsh in the north, the numerous waterfalls of the Ravine X valley form a natural section in the schist. In the middle part, intercalations of grey schist (S_0 marker) occur in the old Minetain (TL) trench situated south of the Butare-Cyangugu road.

(7) A sequence of schists, pinkish-grey, and thin bedded quartzite, about 350 m thick, analogous to the sequence in unit D, but with quartzite layers that are on average thicker (3-5 cm), conformably overlies the pyritic chlorite schist on the normal limb. The dip of S_2 is in general greater than that of S_0-S_1, which confirms the position on the normal limb of an anticline structure with an axis in the chlorite schist to the south (Fig.3).

Microscope study of a sample of an angular boulder of metavolcanic rock (NYSA 55) located above G8 in the Nyungwe, 500 m southeast of the road (Fig.2), revealed millimetre-sized rounded quartz grains scattered evenly throughout a recrystallised matrix of quartz, sericite, muscovite and euhedral biotite altered to chlorite and ferruginous aggregates. One of the quartz grains has a rhyolitic-type corrosion border, which indicates material of volcanic origin in the assemblage. Unfortunately, the outcrop could not be located due to the forest cover.

(8) A predominantly sedimentary sequence, unit C, conformably overlying the grey-pink schist of unit D. The uninterrupted passage between the two units is seen where the road towards Butare cuts into the Uwincka side towards the east. The sequence is characterized by a clear increase in the dynamics of cyclic sedimentation, each cycle comprising from bottom to top:

- a quartzite unit, light coloured, fine grained, poorly sorted, 0.3-1 m thick;
- a schist unit, grey, with centimetre-thick sandy laminations, with common sedimentary structures of the scour-and-fill type, cross stratification and grade bedding. The thickness ranges from 0.1 to 0.6 m. Towards the north (section of the walking track towards Cyurugeyo-Banda) locally a sequence with black-schist clasts confirms some basin instability. At the road level, several S_2 folds (Fig.4) are cut by many faults with abundant quartz veinlets, and associated kink folds, but the way-up orientation is normal throughout up to the large shear zone which marks the southern contact with the Uwincka black quartzite phyllite.

The phase 2 fold axes are overthrust with a sinistral strike-slip component causing upturning of phase 2 fold axes towards the north (N50°E to N5°E). The thrust plane also truncates the quartz schist unit towards the north (Fig.2).

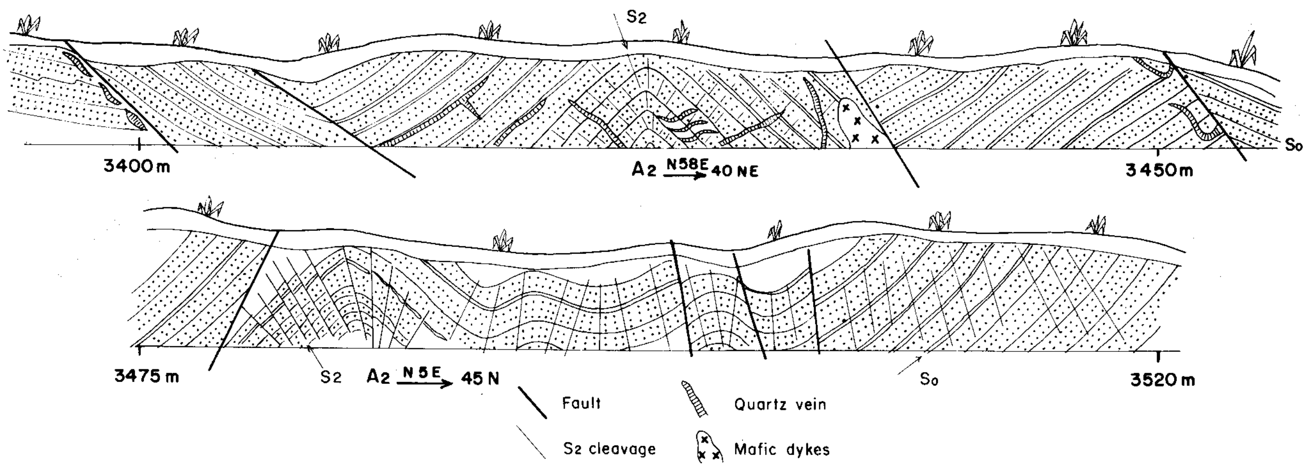

Fig. 4.- Phase 2 fold styles (Bunyerere-Uwincka road) in unit C thick-layered fine quartzite and grey schist.

Detailed study of trenches and drill cores in the Cyurugeyo vein zone show that these are related to another thrust plane which brings a quartzite schist anticline to the north into contact with the same rocks on the normal limb situated further south (Fig.3). The many way-up criteria in the area show inversion of bedding along the whole thrust plane (Fig.3).

Towards the southeast, to the north of the thrust contact, an outlier of metre-thick layers of schist and quartzite is conformable with the black Uwincka quartzitic phyllite.

(9) Uwincka quartzite phyllite, black (unit B, Fig.3), is about 80 m thick. The hardness of the graphite-rich rock varies according to the siliceous content. Hand specimens show many oval millimetre-sized spots filled with quartz-mica aggregates (meta-morphic mineral pseudomorphs). The marker bed contains many pyritic lenses.

(10) A thick predominantly schistose sequence, purple-beige (unit A, fig.3), conformable, occurs up the road to the pass between the Bururi and Nyungwe basins. The rocks are situated outside the gold exploration area, and were not studied in detail.

Many metabasic dykes (H, Fig.3) cut the phase 2 structues, and are more nummerous in the upper quartzite schist unit (C), near the thrust plane below the black quartzite phyllite (B). Unaltered samples of the massive rocks, weathered to brickred clayey material, have not been found. Geochemical analysis of trace elements will probably enable determination of their exact origin. A structural study confirmed the relation with a phase of extension and late fracturing, D3.

3.- STRUCTURAL GEOLOGY

More than 700 structural measurements, made between 1977 and 1981, on the Butare-Cyangugu road cuttings, in trenches and river beds, have been processed by D. Cassard. The pole to the S_0, S_2, S_3 planes, joints, quartz veins and fault planes were projected on the lower hemisphere of Schmidt diagrams (Fig.5a to 5e). Insufficient measurements of lineation hindered drawing statistically valid conclusions. The diagram of poles to S_0 (Fig.5a) confirms the average N130°E orientation of the stratification mapped, even though the later deformation phases produced spreading of the poles. The average dip is 70° to the northeast.

The diagram of poles to S_2 cleavage (Fig.5b) confirms that the average strikes of S_0 and S_2 are paralled, however, with a greater average dip, and less spreading of poles to S_2.

Poles to S_3 (Fig.5c) show displacement to the north: average strike of N175°E and a dip of 80° to the east.

The S_3 fracture cleavage associated with kink folds with subvertical axes is related to later regional north or northeast trending transverse faults.

Many of the faults have a dextral slip component (Fig.2) of about a hectometre which is expressed in outcrop by a system of microfaults of variable slip direction.

Poles to joint planes can be grouped into three populations (Fig.5d):

(1) J1 which is superposed on S_3 and probably has the same origin.

(2) J2 and J3 which group two populations with orthogonal average strike (N55°E and N145°E)

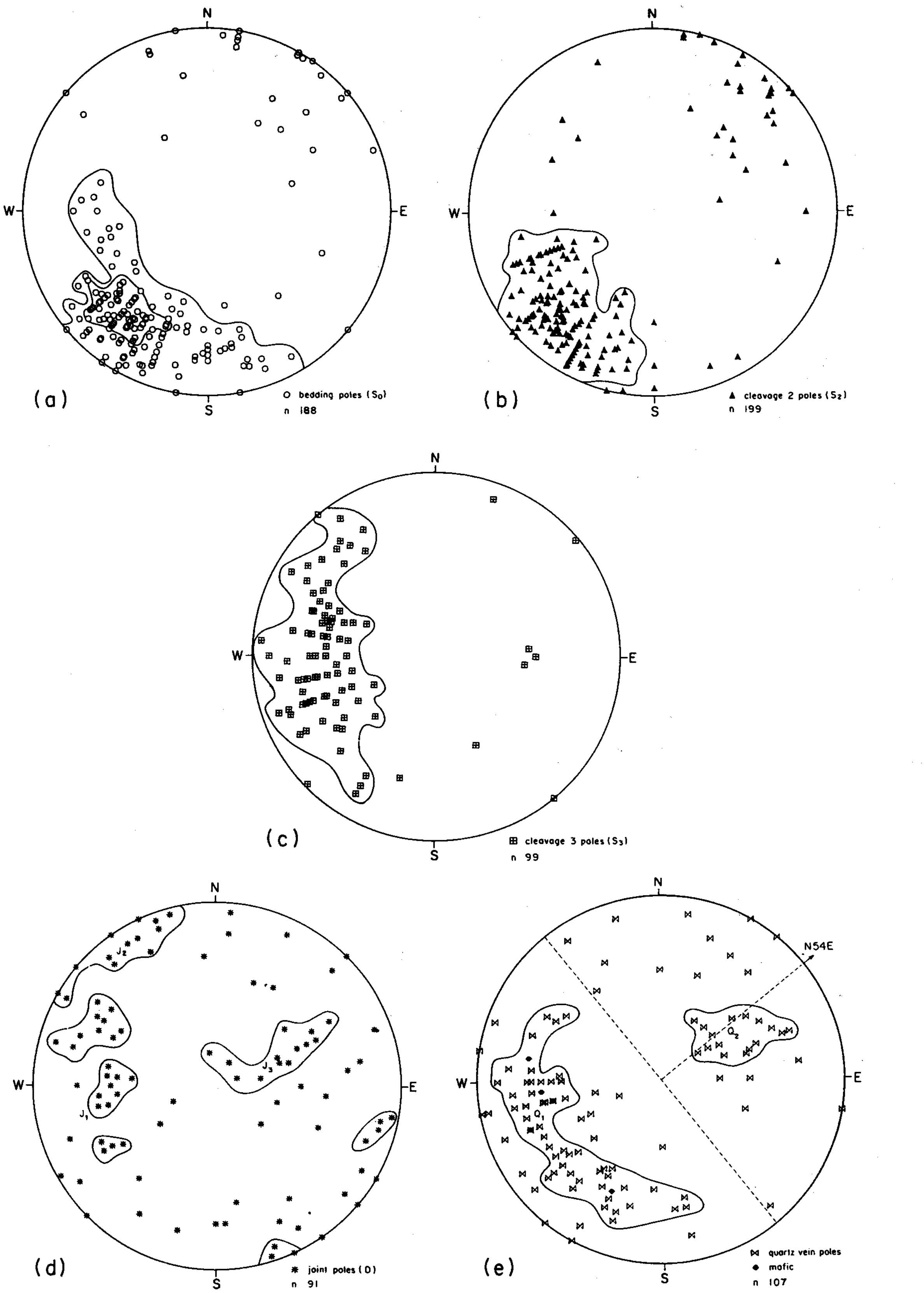

Fig. 5.-

a - Projection to S_0 poles (stratification plane) on the lower hemisphere (Schmidt diagram).

b - Projection to S_2 poles intersecting S_0 (Schmidt diagram).

c - Projection to S_3 poles (Schmidt diagram).

d - Projection to joint poles: J1 is a refraction of S_3; J2 and J3 are orthogonal joint systems associated with phase 2.

e - Projection of poles to quartz veins: population Q2 is superposed fairly well on the J3 field (Fig.5d).

which can be attributed to extension during cylindrical folding of quartzite layers by phase 2.

The projection of poles to quartz veins indicates two populations of planes (Fig.5e):

(1) A population Q1 of poles which are distributed on a great circle with an average strike of N147°E and a steep dip to the northeast which coincides fairly well with a S_0-S_1 plane family (Fig.5). The segregated veins are parallel to S_1, and earlier than J2.

(2) A population Q2 of veins with the same strike but with an average dip of 45° to the west. This population coincides also with the previous J3 joint system.

A few measurements of fault planes were taken only in the northeast end of the section, where the faults, mainly striking N20°E are later than the thrusting phase. Overall, the structural history of the Nyungwe Forest area consists of:

(1) A first folding phase, which produced S_1 cleavage subparallel to S_0, accompanied by orientation of phyllite.

(2) A second folding phase, with fold amplitudes of a hectometre, overturned to the southwest, which produced transverse (cross) S_2 cleavage (fracture cleavage). During the most intensive phase of deformation, the folds evolved to faulted folds, and locally the structures were thrust from the northeast to the southwest. During the compressive phase, younger rocks were superposed on older rocks, facies were truncated, and S_2 axes rotated. The base of the thrust plane comprises many mylonitic intercalations and extensional quartz veinlets.

(3) In deformation phase 3, earlier structures were cut by a N10-20°E to N30-50°E striking fault system which produced dextral slip of about a hectometre and many microfolds (S_2 cleavage drag folds and kink folds) with subvertical axes. Intrusion of the mafic dykes accompanied the late phase fracturing.

A similar evolution, but without late phase 2 thrusting is described to the north of the Kibuye region (Lamens, 1981) and to the west in the Masisi-Saké region of Kivu (Blès, 1972).

The metamorphic grade remained low during J2 as indicated by the reorientation of sericite and chlorite parallel to S_2 around quartz grains, and quartz pressure-shadows around pyrite grains. Amphibole in the orthoamphibolite sills is poikiloblastic, containing inclusions of biotite. The amphibole is of primary magmatic origin, and has undergone retrograde metamorphism to chlorite. Biotite only occurs in schist near the intrusive mafic sills, and formed by very localised thermal metamorphism. The area mapped is a low grade greenschist domain. To the southwest of the Koko river (Fig.1), lepidoblastic chlorite crystallised in the S_2 plane, clearly intersecting the S1-S0 banding in schist, indicating regional thermal metamorphism.

4.- ORIGIN OF CHLORITE SCHIST IN UPPER NYUNGWE

The rhyolitic-facies quartz in a rock sample from upper Nyungwe has led one of the authors (Salpeteur, 1979) to suggest a volcanosedimentary origin for part of the sulfides in the chlorite schist and grey schist in the area. Small oval chlorite aggregates in some chlorite schist facies (NYSA 38, NYSA 770), very similar to amygdales in lava, could indicate metatuff with lava fragments. To check the hypothesis, four thin sections from the facies were studied again recently (NYSA 433, NYSA 206, NYSA 409 and 410) in collaboration with M. Tegyey. Petrographic study confirmed, in NYSA 433 and 206, millimetre-sized oval amygdales filled with colourless magnesian chlorite associated with partly retrograde metamorphosed biotite in a homogeneous matrix of fine-grained quartz, feldspar, chlorite, sericite and many opaque minerals including more than 3% euhedral pyrite. Some of the amygdals contain apatite and plagioclase which is probably albite.

Sample NYSA 206 has two zones of similar composition, one with oval lenses of chlorite and carbonate, and another coarser-grained zone which could have been either less rich in gas, or a fine recrystallised tuff. The contact between the amygdaloidal lava and the tuff is deformed in kink folds intersected by S_2.

Sample NYSA 409 consists of a matrix of similar composition with abundant muscovite, rectangular cavities replaced by chlorite, aggregates of cryptocrystalline quartz surrounded by a colourless quartz and sulfides which could be former lithic fragments. The amygdaloidal rocks are analogous to amygdaloidal metadacite lava which occurs elsewhere in less metamorphosed submarine volcanic rocks such as, for example, the Rio Tinto Devonian-Carboniferous province in Spain (Salpeteur, 1976).

A multi-element analysis by the ICP method, controlled by X-Ray fluorescence in the BRGM laboratory, on lava sample NYSA 433 revealed a composition very close to amygdaloidal metavolcanic rocks described in Burundi (table 1) and elsewhere in the world; the rock in the R1/R2 diagram (La Roche (de) *et al.*, 1980) has a potassic metadacite composition (Fig.6). X-Ray fluorescence enabled confirming the igneous origin.

Table 1.- Comparison of average compositions (major elements) of a metadacite lava from Nyungwe, an analogous rock from northwest Burundi, a recent dacite, quartz porphyry, and an amygdaloidal metadacite from the Paymogo volcanosedimentary ridge (Huelva Province, Spain).

	SiO_2	Al_2O_3	Fe tot	CaO	MgO	Na_2O	K_2O	MnO	TiO_2	P_2O_5
Metadacite amygdaloidal (NYSA 433)	63.6	18	3.6	1.1	2.6	0.29	4.9	0.01	0.98	0.12
Metadacite amygdaloidal (3)	67.1	18	3.4	-	1.04		4.9	0.01	0.65	0.07
Metadacite amygdaloidal (2)	64.0	14.18	5.17	2.27	3.0	4.4	1.27	0.10	0.68	-
Dacite (1) 80 analyses (average)	65.0	15.9	4.7	4.32	1.78	3.8	2.2	0.09	0.58	0.15
Quartz porphyry (4)	63.3	16.6	4.5	4.7	2.15	3.5	2.8	tr.	0.4	0.14

(1) Le Maître (1978)

(2) Salpeteur I., Huelva province (1976). Amygdaloidal porphyritic dacite with rhyolitic quartz, pyroxene lacking

(3) Vanassche F. (1981). Univ. Gent. Burundi

(4) Rösler H.J. and Lange H. (1972)

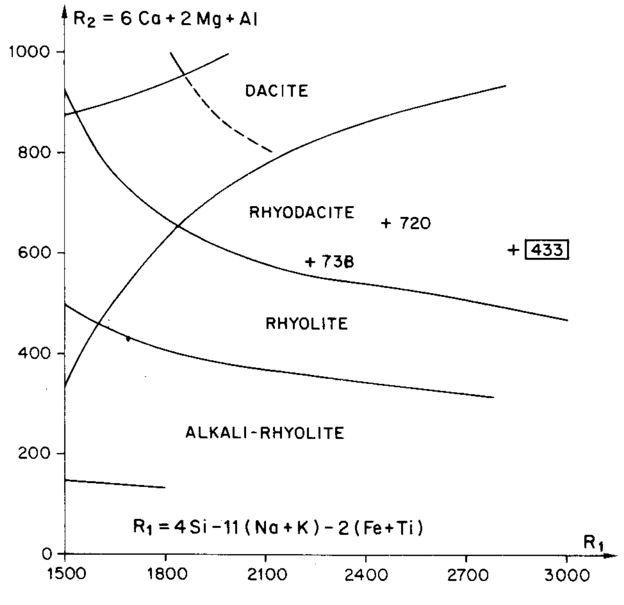

Fig. 6.- De La Roche *et al.*, 1980 diagram of R1 [4Si - 11(NA+K)-2(Fe+Ti)]/R2(6Ca+2Mg+Al) confirming the position of sample NYSA 433 in the rhyodacite field. NYSA 720 represents a chloritic metavolcanite of similar composition from Nyungwe River and 73B a Pb-Zn enriched metatuff from Rangiro (Fig.1).

Sample NYSA 720 represents a chloritic metavolcanite of similar composition collected farther downstream in the Nyungwe River and sample 73B a Pb-Zn anomalous metatuff from Rangiro prospect, 6 km to the north (Fig.1).

Recently, similar rocks have been described in the Kitwenge area in Burundi (Vanassche, 1981) and amygdaloidal metabasalt intercalations in amphibolite schist are reported from northwest Burundi (Ntungicimpaye and Kampunzu, 1987) in rocks of the same age which constitute the southern extension of the Nyungwe region.

Klerkx *et al.* (1987) also reproted thin intercalations of rhyodacitic metavolcanic rock in argillaceous rocks in the basal part of the Burundian, in the eastern Burundi, dated at 1350 Ma. The calc-alkalic volcanic rocks in the assemblage attributed to the lower Burundian are of primary importance for the geostructural model and metallogeny of Burundian rocks.

The high K/Na ratio (17) of lava NYSA 433 compared to that of classical metadacite (0.3 to 0.6, table 1) may indicate early migration of alkalies in the rocks in relation with hydrothermal alteration. It is known that the evolution of the K/Na ratio may indicate a proximal geochemical alteration halo around volcanosedimentary sulfide deposits (Govett and Pwa, 1981) or prophyry Mo-type deposits (Thomas and Galey, 1982).

5.- CONCLUSION : LOCAL STRATIGRAPHY-METALLOGENY

The structural study and detailed mapping in the upper Nyungwe area enabled proposing a local stratigraphic column (Fig.7) which comprises seven characteristic units which are, from bottom to top:

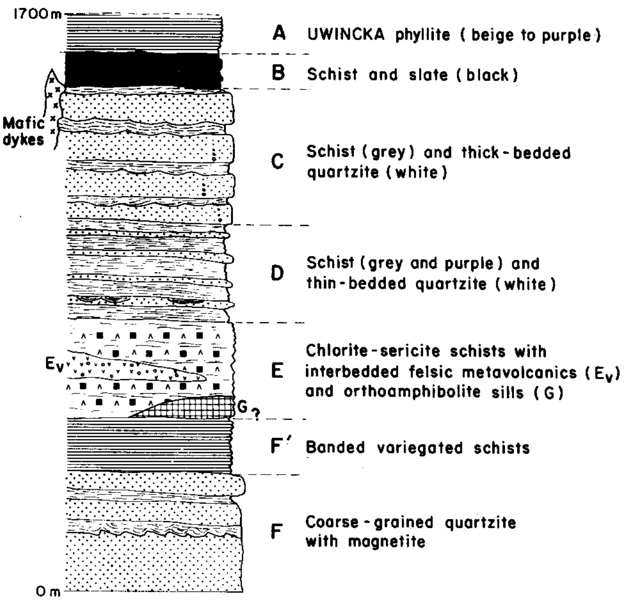

Fig. 7.- Stratigraphic column of the lower Burundian in upper Nyungwe.

(1) Lower quartzite (F) metre-thick layers, coarse grained, with light-grey schist alternations, about 350 m thick. The quartzite is rich in octahedral magnetite.

(2) Banded variegated schist (F') about 180 m thick.

(3) Chlorite schist, pyritic (E) with metatuff and rhyodacitic metalava intercalations, about 260 m thick.

(4) Schist, grey-purple, with thin bedded quartzite (D) about 400 m thick.

(5) Schist and quartzite, thick bedded, with laminations, 400 m thick (C).

(6) Quartzitic phyllite, black, about 80 m thick (B).

(7) Uwincka schist, purple and beige (A), thickness unknown.

The vertical sedimentological evolution of the deposits expresses low energy, and the more distal character of the clastic sediments; the first cycle comprises: coarse-grained quartzite, fine-grained quartzite with magnetite, microbanded schist which marks the first pause in sedimentation. The second cycle starts with fine-grained detrital volcanics and rare intercalations of metavolcanics, then the dynamics increase continuously which is expressed by progressive thickening of quartzite layers, and erosions of just deposited sediments. Next, a second pause is marked by deposition of black mud and the Uwincka schist.

The exact correlation of these rocks with the Rangiro sandy schist further to the north (Fig.1) and with the Karamba conglomerate, to the west, is in progress, and should give the relative age.

According to recent studies (Buyagu and Trefois, 1983), the Bunyerere schist and sandstone from part of a group of metasedimentary rocks with abundant black schist, microbanded and lacking amphibolite, which characterize the Karongi formation deposited after the older Kibuye formation, and overlain conformably by Ntendezi formation conglomerate and quartzite.

The criteria «lack of amphibolite» is a poor stratigraphic argument because they are intrusive. The metavolcanic rocks in the Burundian chlorite schist of the Nyungwe are better criteria for correlation between the units, even if the volcanism is diachronous. The metavolcanite in the schist of the Mabayi region of Burundi enables relating it to that of the Nyungwe.

Fine sandstone - black schist alternations are known in many places in Rwanda:

- On the northern bank of Lake Muhazi, they are recorded at the top of the lower Burundian, according to the geological map of Rwanda.
- Black phyllite of the tungsten belt locally consits of fine sandy beds, and is attributed to the base of the lower assemblage, under the Nduba quartzite marker (Petricec, 1977; Rusanganwa, 1988). Recurrences of facies are well known in shallow intracontinental basins: the search for new tools such as lithogeochemistry, heavy mineral spectra analysis, and quartz thermoluminescence should allow establishing the correlation between the various regions mapped in detail.

On a regional scale, most of the gold-bearing rivers of western Burundi (Mabayi district: Ntungicimpaye *et al.*, 1987; Salpeteur, 1990), southern Maniema (Namoya district: Kazmitcheff, 1968), central Kivu (Twangitza district: Safiannikoff, 1972) cut similar pyritic metavolcanics of Early Burundian age.

This affinity leads us to suspect that the calc-alkaline volcanic activity played a major role in the primary deposition of a low-grade stratabound gold mineralization. The main controls of the late-tectonic gold vein systems and siliceous breccias are not yet fully understood and require more detailed studies (Gunther and Pohl, 1988; Salpeteur, 1990).

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