Hydrothermal desilicification, alkali leaching and oxidation in metapelites of the Rosebel gold district in the Paleoproterozoic Marowijne Greenstone Belt, Suriname

R. Naipal[1,2], S. B. Kroonenberg[1,3], L.M. Kriegsman[1,4], P. R. D. Mason[2], M.J. van Bergen[2]

Abstract

The Rosebel rocks from the Marowijne Greenstone belt (MGB) have been affected by oxidative hydrothermal fluids accompanied by strong desilication, and alkali leaching. A unique drill core LA88 from this area might be evidence for these processes. This drill core is studied in detail and these rocks seemed to be a fine mafic volcaniclastic sediment based on the low SiO_2 and high Mg, Cr and Ni content and absence of feldspars and quartz. However, the bulk major elements chemical composition does not correspond with mafic or ultramafic rocks and these rocks consists of small zircons. Dating showed a whole range of ages between 2.11 and 3.4 Ga, and thus should have a detrital origin.

Introduction

- The fluvial Rosebel Formation is the uppermost unit in the MGB of Suriname (2.26-2.06 Ga, Kroonenberg et al., 2016).
- Gold in the Rosebel gold district is mainly associated with quartz and quartz-carbonate veins.
- The sulfides in the gold-bearing veins suggests that most mineralizing fluids had a relatively reduced signature.
- Here, we document a contrasting case of oxidative hydrothermal alteration in the Rosebel area, which was accompanied by strong desilicification and alkali leaching.

Geological setting

The Marowijne Greenstone Belt in Suriname consists of three units (Fig. 1), in chronological order the Paramaka submarine mafic-felsic volcanics, volcaniclastics and marine chemical sediments; the Armina Formation, consisting of turbiditic sequences of greywackes and shales, and the Rosebel Formation with epicontinental conglomerates and arenites, deposited unconformably upon the previous units.

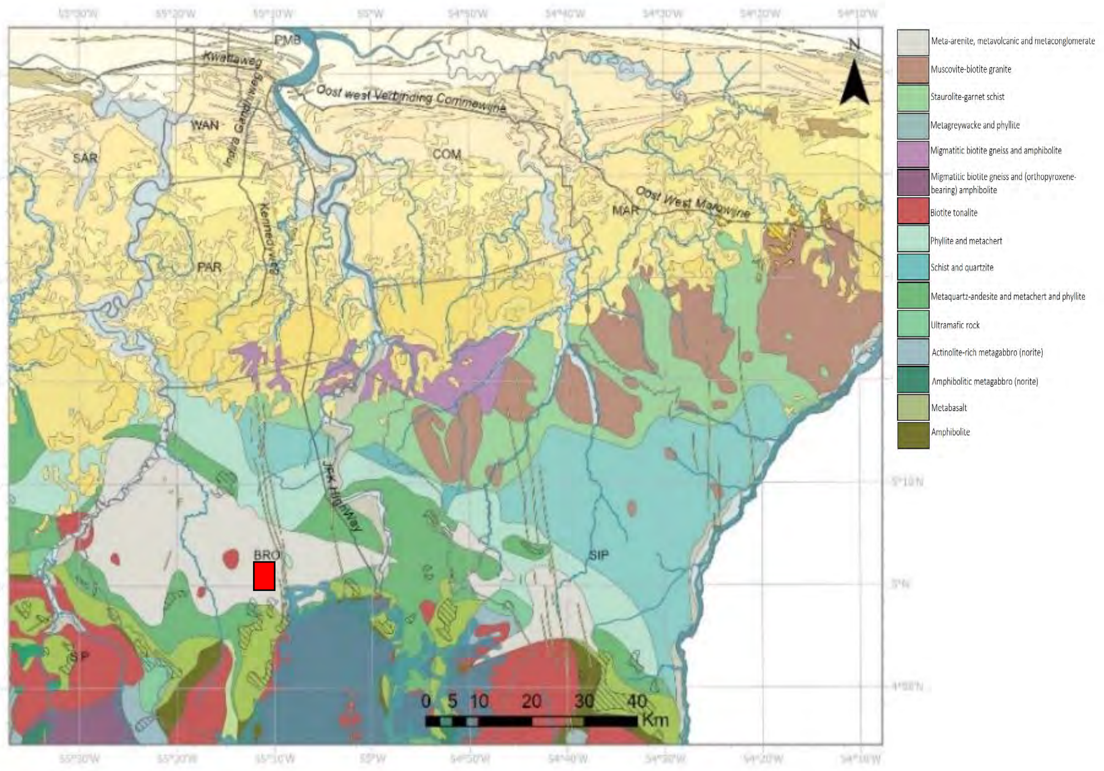

Figure 1: Regional geology of the NE Marowijne Greenstone Belt, red box indicates study area (Geological and Mining Department of Suriname, 2018).

Rosebel Formation

- Consists of a polygenetic basal conglomerate.
- A thick sequence of cross-bedded arenites, with a deposit of heavy minerals (magnetite), at the base.
- There are a few conglomeratic intercalations and some shale levels (Daoust, 2016).
- The study area is located in the Rosebel gold district in the central part of the synclinorium (Fig. 2).

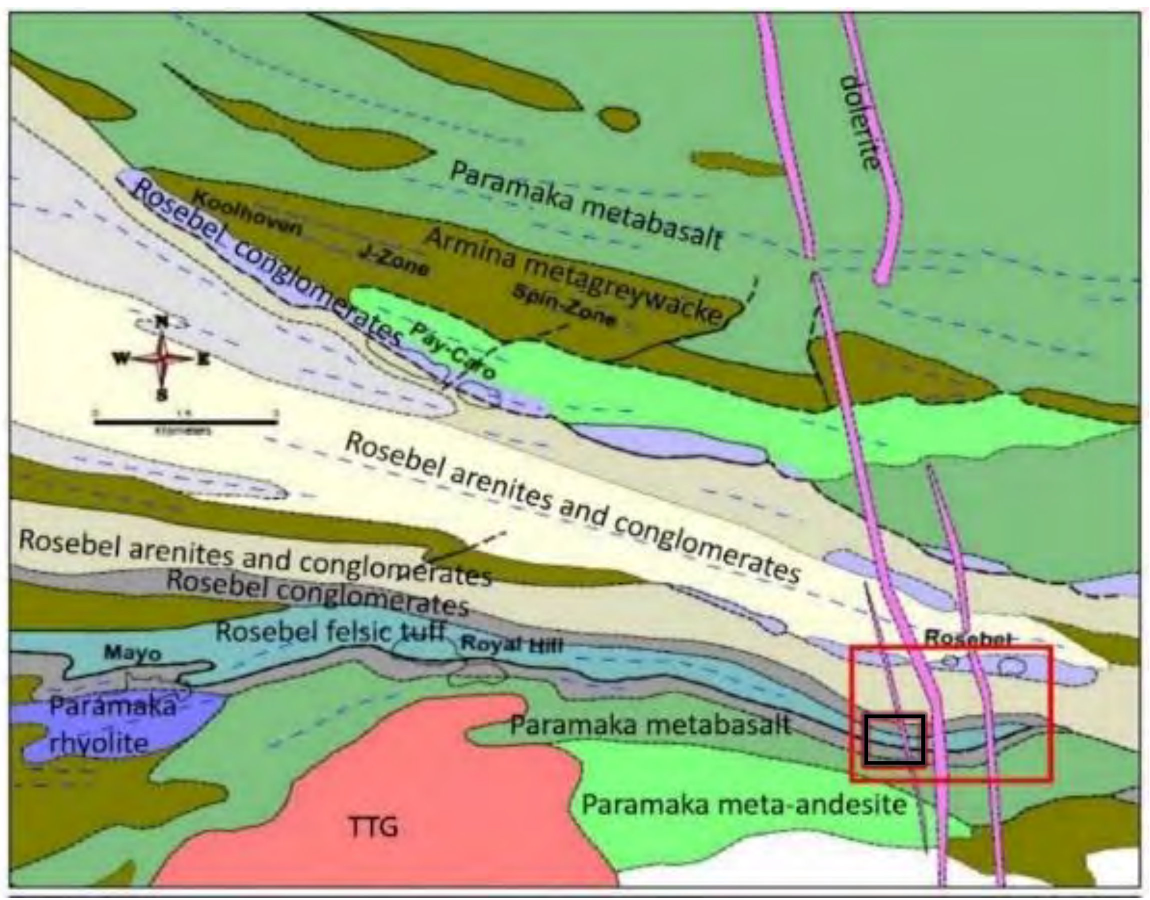

Figure 2: Geological map southern part of RGM concession, black box indicates study area (modified after Watson, 2000).

- The GMD drilled seven diamond drill holes in 1957 (Fig. 2), to check for Cu mineralization.
- LA88 appeared to contain an unusual series of pure orange-coloured chlorite with veins of epidote, piemontite and specular hematite.

Methods and Techniques

- Literature research
- Thin section analysis
- XRF (Major elements)
- LA-ICP-MS (Trace elements)
- Tabletop SEM (Mineral analysis)

Results

Petrology

Figure 3: Drill cores LA88 1-6.

- **LA88-1:** very finely laminated dark green chlorite rock with lighter laminae of zoned epidote, piemontite, hematite, zircon, rutile, and leucoxene.
- **LA88-2:** very finely laminated, alternating lighter (epidote and chlorite) and darker (chlorite and irregular zoned epidote veins).
- **LA88-3:** light-green laminated chlorite-epidote rock with alternating darker (chlorite-rich) lighter (piemontite).
- **LA88-4:** very finely laminated, orange coloured with ferrichlorite, piemontite veins and blebs.
- **LA88-5:** light green, laminated with alternating mm sized chlorite-rich and epidote-rich laminae.
- **LA88-6:** laminated slightly porous, which may reflect the dissolution of a soluble phase, such as carbonate.

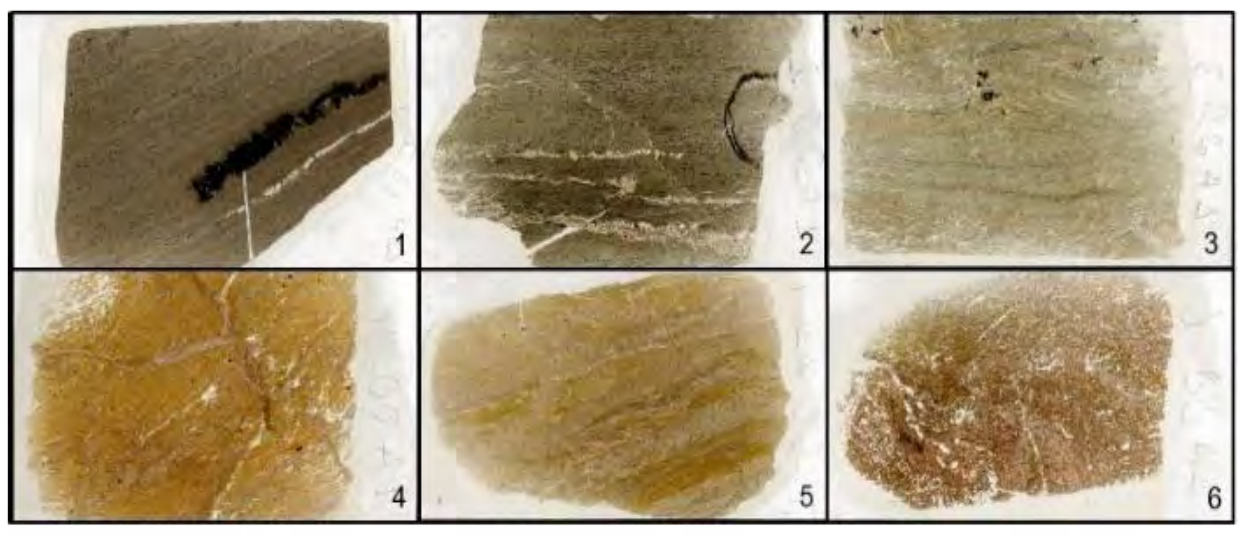

Figure 4: Thin section of LA88 1-6.

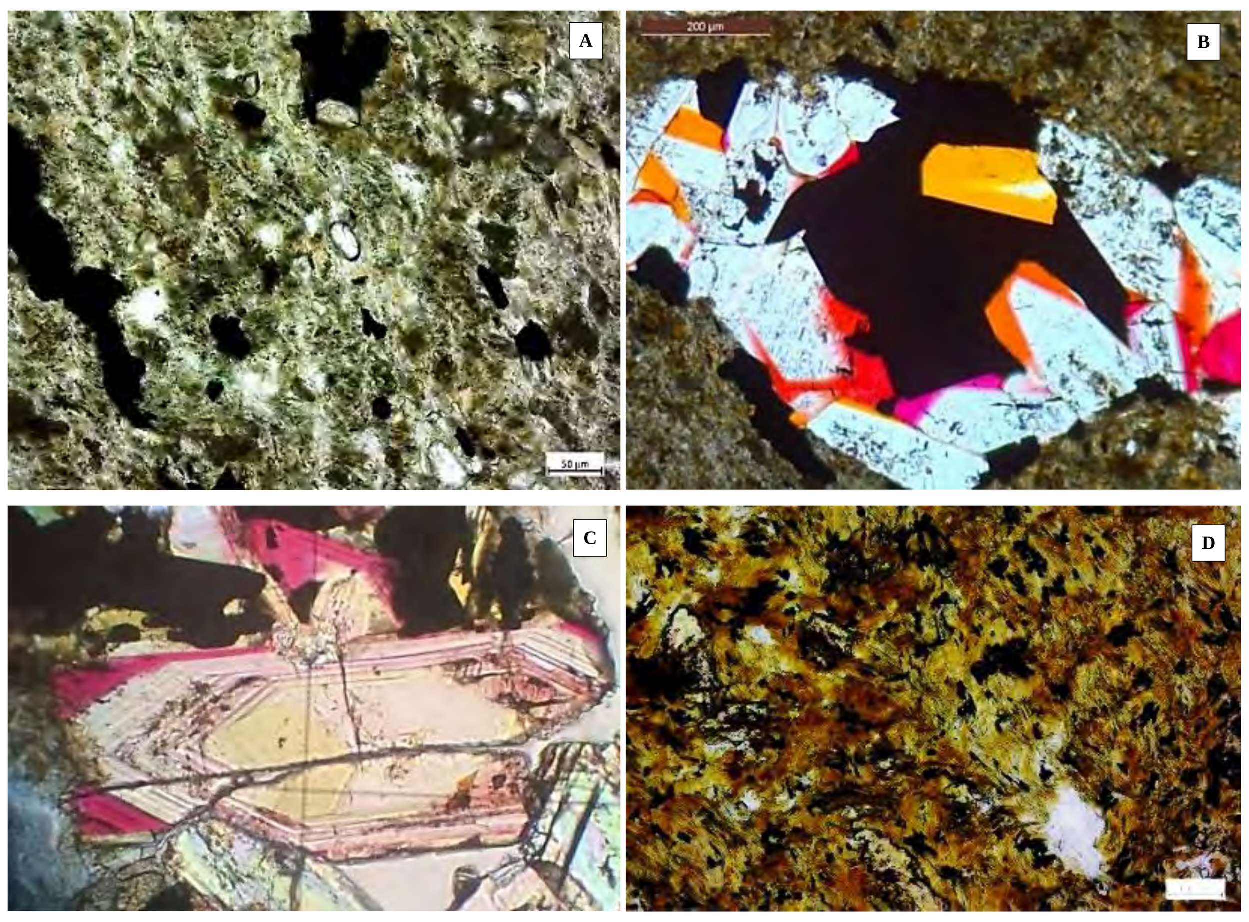

Figure 5: (A) Zircons in dense chloritic mass of LA88-1;(B) epidote-piemontite hematite vein in LA88-2; (C) zoned epidote-piemontite in LA88-2 (D) orange ferrichlorite in LA88-4.

Geochemistry: Major elements

Table 1: Major elements of LA88 1-6

Element		SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	Total	Ba	Cr	Ni	Sr	Zr
Sample	Depth	%	%	%	%	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
LA88-1	15.43-15.54m	28.29	3.43	19.80	23.74	0.14	21.68	2.83	0.00	0.02	0.00	99.94	318	697	85	181	818
LA88-2	17.54-17.65m	29.80	4.00	21.57	19.57	0.15	20.77	3.59	0.00	0.01	0.01	99.47	261	789	122	342	530
LA88-3	18-23-18.31m	34.56	2.39	22.18	15.39	0.26	11.93	9.91	0.00	0.01	0.02	96.66	244	531	96	1530	695
LA88-4	19.58-19.65m	32.43	2.37	22.13	16.86	0.39	18.36	5.50	0.00	0.00	0.14	98.17	284	900	344	606	349
LA88-5	20.31- 20.52m	34.48	1.93	21.94	14.65	0.51	12.59	11.62	0.00	0.00	0.09	97.82	245	444	141	1200	444
LA88-6	21.67-22.56m	35.34	1.33	21.83	14.18	0.90	9.05	14.18	0.00	0.00	0.00	96.80	261	473	72	1380	598

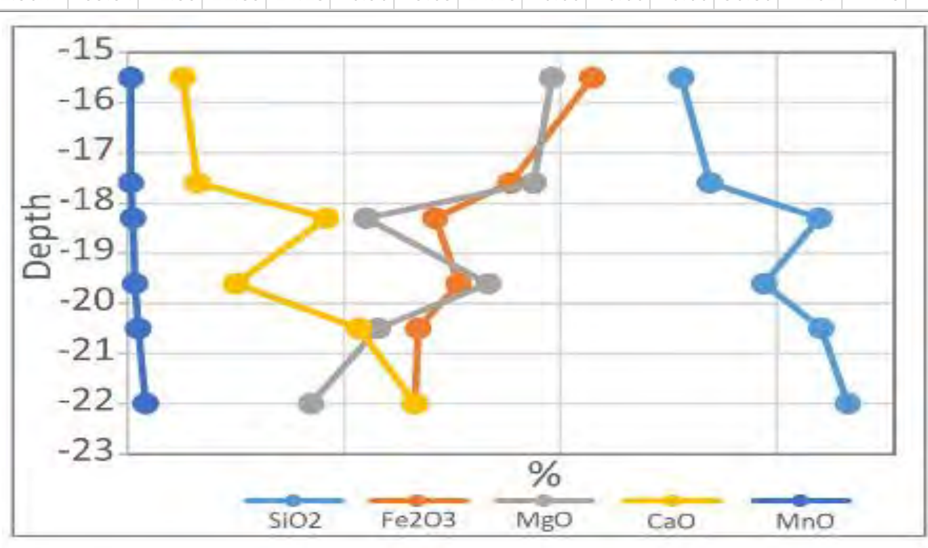

Figure 6: Major elements versus depth.

Results

Geochemistry: Trace elements

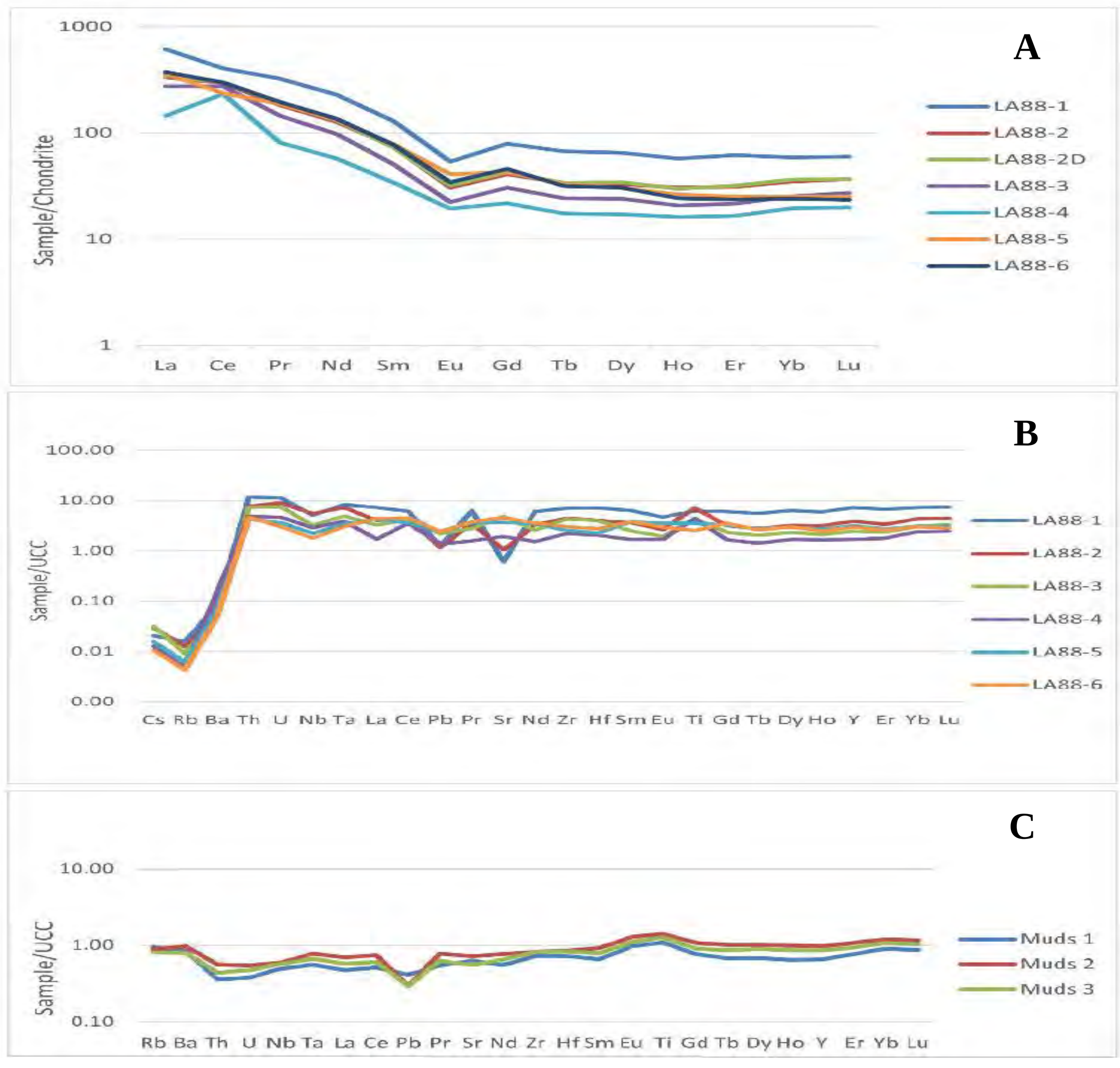

Figure 7: (A) LA88 1-6 samples normalised to chondrite; (B) LA88 1-6 samples normalised to Upper Continental Crust; (C) Rosebel mudstones (KH 281) (Daoust et al., 2011) normalised to Upper Continental Crust.

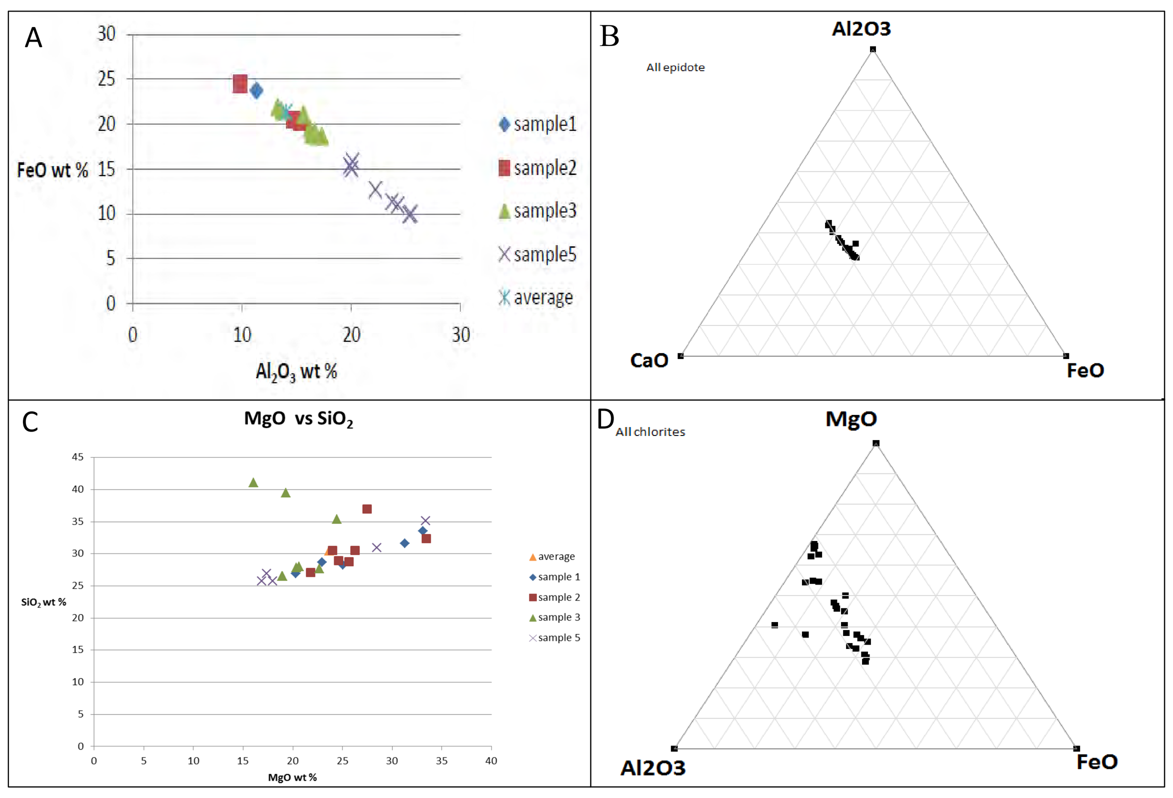

Figure 8: (A) Al_2O_3 wt% versus FeO wt % of epidote; (B) compositional range of epidote in a CaO-FeO- Al_2O_3 diagram; (C) MgO wt% versus SiO_2 wt % of chlorite; (D) compositional range of chlorite in a CaO-FeO- Al_2O_3 diagram.

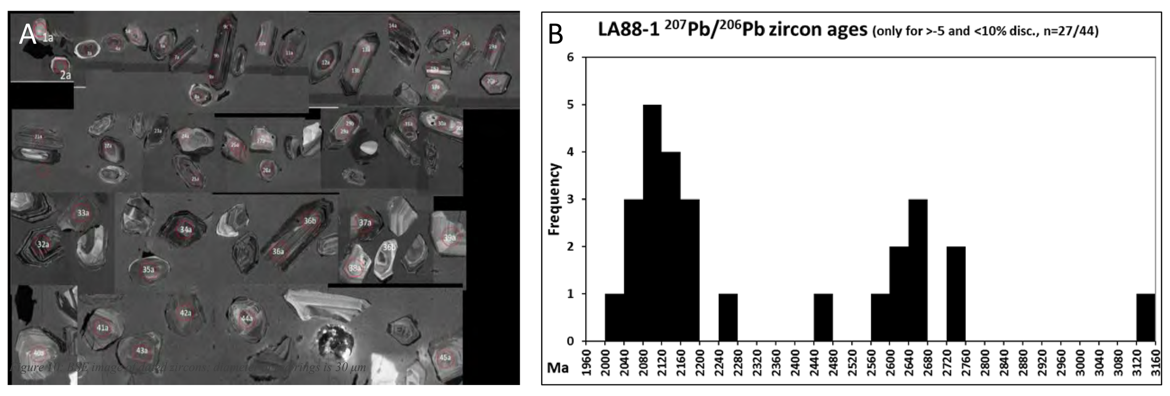

Figure 9: (A) BSE image of dated zircons; diameter of red rings ~ 30 μm; (B) graph showing zircon age distributions.

Conclusions

- Absence of felsic minerals, with low SiO_2 and high MgO, Cr and Ni: fine-grained mafic volcaniclastics.
- Absence of alkali metals, elevated Al_2O_3, signatures of immobile trace elements and the detrital zircons do not support such an origin.
- Probably these rocks represent relatively common Rosebel shales, but strongly altered by hydrothermal fluids.
- Which have led to desilicification and leaching of alkalis.
- Hematite, ferrichlorite and epidote are minerals incorporating Fe^{3+}, piemontite contains Mn^{3+}: oxidizing nature for the hydrothermal fluids that altered the original shales.
- Further research to find out whether this type of hydrothermal activity has implications for the gold mineralization.

References

- Daoust, C., Voicu, G., Brisson, H. & Gauthier, M. (2011). Geological setting of the Paleoproterozoic Rosebel gold district, Guiana Shield, Suriname. Journal of South American Earth Sciences 32: 222–245.
- Daoust C. (2016). Caractérisation stratigraphique, structural et géochimique du District Minéralisé De Rosebel (Suriname) dans le cadrede l'évolution géodynamique du bouclier Guyanais, Thése présentée comme exigence partielle du Doctorat en Sciences De LaTerre et de l'atmosphère, Université de Québec à Montréal, pp. 1-353.
- Kroonenberg, S. B., de Roever, E. W. F., Fraga, L. M., Reis, N. J., Faraco, T., Lafon, J.-M., Wong, T. E. (2016). Paleoproterozoic evolution of the Guiana Shield in Suriname: A revised model. Netherlands Journal of Geosciences - Geologie en Mijnbouw, 95(4), 491–522.
- Watson T. (2008). Volcanism and Sedimentation: New Insights into Arc-Related Volcanism and Sediment Deposition in a Synkinematic Paleoproterozoic Basin: Rosebel Gold Mine, Northeastern Suriname, MSc thesis, University of North Carolina at Department of Geological Sciences, pp. 1 – 96.

1. Anton de Kom University of Suriname, department of Geosciences, Paramaribo-Suriname: renoesha.naipal@uvs.edu; 2. Utrecht University, department of Earth Sciences, Utrecht-the Netherlands: p.mason@uu.nl; M.J.vanBergen@uu.nl; 3. Delft University of Technology, Delft-the Netherlands: salomonkroonenberg@gmail.com; 4. Naturalis Biodiversity Center, Leiden-the Netherlands: leo.kriegsman@naturalis.nl.

SEMIF Suriname Environmental and Mining Foundation — FACULTEIT der TECHNOLOGISCHE WETENSCHAPPEN — Utrecht University