

LEWIS AND CLARK FUND FOR EXPLORATION AND FIELD RESEARCH IN ASTROBIOLOGY

Banded Iron formations (BIFs): Key to the Rise of Atmospheric Oxygen

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Fieldwork dates: August 17-September 4th (19 days fieldwork)

1. Project Fieldwork Report

The requested funds were used for fieldwork to the late Archean/early Proterozoic Vale S.A. and Samarco Mineração S.A. deposits in the Quadrilátero Ferrífero (QF) district of the state of Minas Gerais, southern Brazil. Participants included Bridget Lee (PhD student), Prof. Timothy Lyons, Prof. Andrey Bekker, Prof. Carlos Alberto Rosier and Prof. Ernesto Oliveira. The aim of the trip was to obtain detailed outcrop description and collection of samples from both outcrop and different industry drill core repositories.

The 15,000 km² portion of the Brazilian highlands, just south of the city of Belo Horizonte (Figure 1), became known as Quadrilátero Ferrífero (“Iron Quadrangle and abbreviated “QF”) for the fact it is delimited by four almost mutually perpendicular ridges underlain by Paleoproterozoic banded-iron formation and quartzites, which rise above lowlands containing deeply weathered Archean gneisses and schists. The Precambrian section exposed in the QF consists of four major lithostratigraphic units: (1) Archean metamorphic complexes; (2) the Archean Rio das Velhas Supergroup; (3) the Paleoproterozoic Minas Supergroup, and (4) the Itacolomi Group (Figure 1).

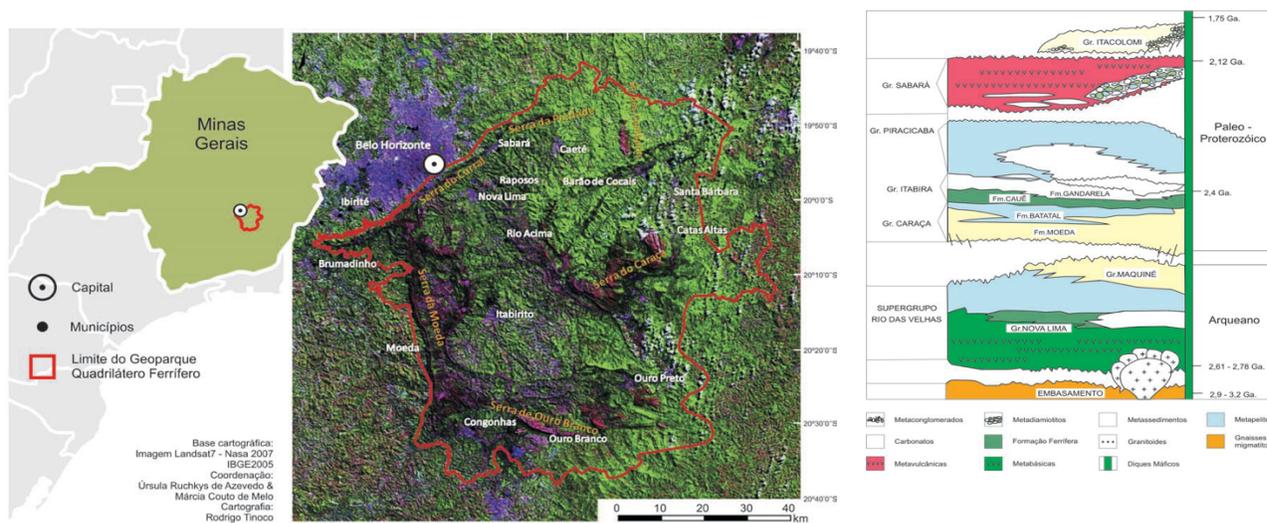


Figure 1: Topographic map of the QF area, showing the location of the fieldwork locations. Stratigraphic column of the supracrustal sequences in Quadrilátero Ferrífero. Modified after Dorr (1969) and Alkmim and Marshak (1998).

Several stops were made on the way to look at outcrops and discuss the section exposed in the QF (Figure 2). It took us seven days to travel about 830 km around the Quadrilátero Ferrífero.

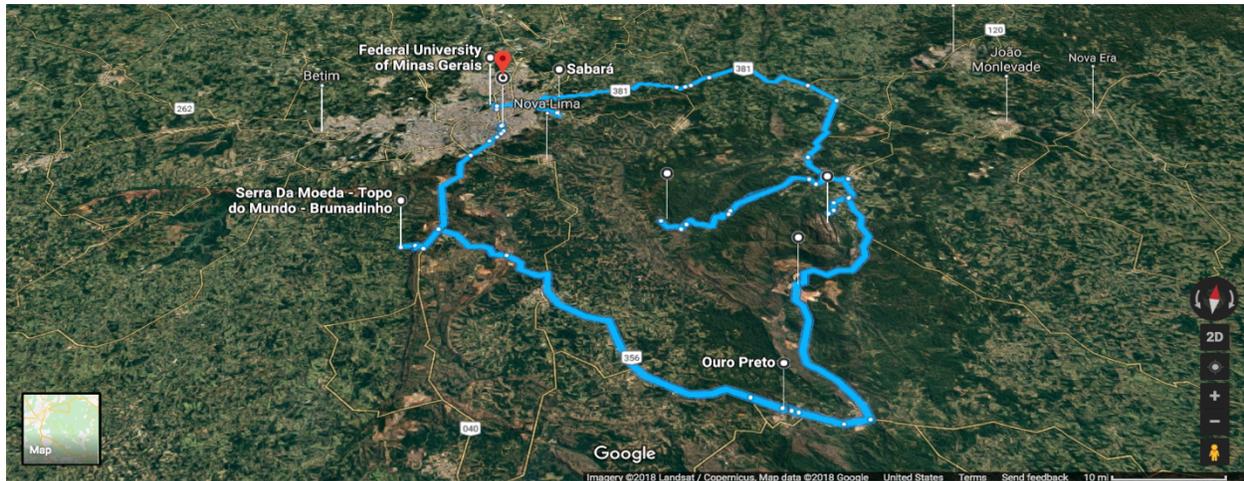


Figure 2: Five main stops to map and check the Paleoproterozoic rocks above Archean unit of the Quadrilátero Ferrífero: 1-Federal University of Minas Gerais, 2-Sabará, 3-The National Park of Gandarela, 4- Ouro Preto, 5-Serra Da Moeda - Topo do Mundo, 5-Belo Horizonte.

- **Day 1,2 and 3**

Trip started at the Federal University of Minas Gerais to Sabará. We stopped at Pico de Itabira ($43^{\circ}52'01''$ W $20^{\circ}14'24''$ S) and Mina de Corrego do Meio ($43^{\circ}47'30''$ W $19^{\circ}52'05''$ S). This day was devoted to aspects of the stratigraphy of the upper section of the Minas Supergroup, see the reserve of hematite deposits and collect outcrop samples.



Figure 3: Cauê Formation.

- **Day 4,5 and 6**

The stops focus the stratigraphy of the lower portion of Paleoproterozoic Minas Supergroup, and the deformation history of the southern QF. The lower and middle portions of the Minas Supergroup are currently interpreted as a passive margin section developed between 2,6 and 2,4 Ga, may also contain the record of a glacial event. We went to the Gruta de Nossa Senhora ($42^{\circ}28'24''$ W $20^{\circ}18'19''$ S) at National Park of Gandarela and Capao do Lana ($43^{\circ}37'13''$ W $20^{\circ}25'08''$ S) in Ouro Preto. In this trip, we were able to see the cut exposes the unconformity

between the Archean Nova Lima and the Paleoproterozoic Moeda, the basal unit of the Minas Supergroup which in its turn is overlain by the Batatal and Cauê Banded Iron Formation. Outcrop units were strongly deformed and attenuated within a layer-parallel shear zone developed on the northern limb of the Dom Bosco syncline. During the trip we also encountered the mining activities exposed the upper portion of the 2,4 Ga old Gandarela Formation. The lower portion of the Gandarela Formation crops out in the road cuts. We collected few outcrop samples from each site visited.



Figure 4: The lower portion of the Gandarela Formation crops out in the road cuts.

- **Day 7,8, and 9**

For last 3 days of fieldwork we stopped at The Pico Mine is also located on the eastern limb of the Moeda Syncline, Serra Da Moeda (43°59'20" W 20°07'02" S) and Serra da Rola Moca near Topo do Mundo (44°01'59"W 20°03'38"S) before coming back to Belo Horizonte. North standing the iron formation was folded, faulted and sheared. We didn't see any shear zones cut through the adjacent quartzites of the Moeda Formation.



Figure 5: Carlos Alberto Rosier presenting the geology of Minas Supergroup to the research team.

- **Day 10 to19**

Last ten days were used to collect samples from the mine repositories from Vale S.A. and Samarco Mineração S.A. with a guidance from each company site geologists.

We collected 260 samples. Depths of the drill core samples ranged from 540-1230 m, allowing us to recover unweathered materials from the 2.7 billion-year-old (Ga) Caraça Group, the Batatal (2.6 Ga) and small set of samples of the Itabira (2.4 Ga) group.





Figure 6: Overview of the mine infrastructure of the Samarco Mineração S.A.



Picture 7: Mine repository at the Vale S.A.

2. Future Plan

Due to the internal problems with the Vale S.A., we were not able to acquire enough samples from the Itabira (2.4 Ga) group which is essential part of the project. For this reason, we have another trip taking place in November 11th to November 23rd. In this trip I will be traveling by myself and joining with the Vale S.A. geologist to collect the remaining samples.