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JSE
SUPPLEMENTARY MATERIAL

Appendix 2

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1. Description of the new studied sites

SITE 1

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	237204	7415368	569	1m	Córrego Alegre

Outcrop of a riverbed with a small waterfall located on the western edge of the study area. It consists of the contact between a yellow sandstone layer (facies Smf; table) (Figure A2.1) and an orange alteration cover approximately 1.5 m thick, fine to very fine sandstone, with plane parallel stratification (S_0=290°/15°).

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Figure A2.1 – Outcrop of the fine, stratified sandstone (Smf).

Two layers can be observed: below, one composed of massive, grey, very fine sandstone lobes (Ssp), 0.2 m thick, with crescent fractures; the other, above, consists of a 1.5 m thick light gray sandy siltstone (Fl) (Figure A2.2). It exhibits a black alteration cover, with silt and very fine sand interbedding, tabular and with internal millimetric laminar structure.

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Figure A2.2 – Photo of the sandy siltstone (Fl) below the very fine sandstone (Ssp).

SITE 2

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	254316	7413655	604	1m	Córrego Alegre

Outcrop along a cut in the road right-of-way. Polymictic diamictite (Dm) at the base of the outcrop, with sandy matrix and faceted clasts <10 cm. Above, an outcrop 2 m thick, consisting yellow, fine sandstone (Smm), with a reddish alteration cover. It consists of coarse feldspar and quartz matrix and grains. This outcrop has two types of fractures: the main ones are subvertical, rugose surface fractures, of millimetric displacement; the others are curved fractures, due to slumps (Figure A2.3) (S_0=327°/02°; fractures = N-S/90° and 345°/50°). The deposition of these facies is associated with the action of subaqueous gravity flows (debris flow).

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Figure A2.3 – Inclined fractures, due to slumps.

SITE 3

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	251116	7412796	600	1m	Córrego Alegre

Outcrop along different cuts in the construction yard at Km 90 of Castelo Branco Highway. First wall (E-W): begins with a 1 m thick package of diamictite (Df) (Figure A2.4) at the base, with silty-clayish matrix, immature, with angular pebbles of quartz, feldspar and other lithic fragments. There is a sharp contact with a sandstone bed marked by a manganese oxide level. The sandstone bed is filling a channeled geometry, marked by a level of clasts at the base (Figure A2.5). The yellowish sandstone is characterized by its coarse grain size at the base, fining upwards, and by its tabular cross stratification - tangential to the top and base – in its interior (Sh). It is a at least 4 m thick package with some metric strata.

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Figure A2.4 - Photo of the clayish diamictite (Df).

Figure A2.5 - Photo of the conglomeratic level below the tabular cross stratification (Gp).

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Second wall (N-S): The wall cut (Figure A2.6) is perpendicular to the last one. It begins with a metric thickness diamictite package (Df) with clayish matrix, followed by another metric diamictite package (Dm) with sandy matrix. Above, there is a 2 m thick layer containing interbedding of fine to medium sandstone (Smf) with the same sandy diamictite. Covering the top of the wall, the same sandstone occurs, without the interbedding.

When the sandstone was deposited over the diamictite, the diamictite still exhibited a plastic behavior, which caused deformation of both sedimentary packages, flame structures (Figure A2.7), load structures, and block rotation.

Figure A2.6 - Outcrop with orientation S - N of the site 3 (Facies Gp / Dm / Smf; Tables 1, 3).

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Figure A2.7 - Photo of a flame structure.

The third wall (E-W) has a cut parallel to the first wall described at this site (Figure A2.8). It is constituted by a coarse, conglomeratic sandstone layer (Gp), sandy diamictite (Dm), clayish diamictite (Df), and lastly, by a fine sandstone (Smm), also containing coarse sand grains. In this context of facies, the diamictite bodies (Dm) generally present sigmoidal external geometry. Deformation features can be seen.

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Figure A2.8 - Photo of the outcrop with an E-W direction

SITE 4

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	260228	7410598	647	1m	Córrego Alegre

Road cut along the shoulder of Castelo Branco Highway. Base formed by a 1.0 m layer of grey, clayish siltstone (Fm). A package of 4 m fine, yellowish white, sandy siltstone (Fl), with decimetric strata, and silt and very fine sand levels (facies Ssp / Fl). Irregular, undulated external geometry, with ripples at the top (frontal tabular cross stratification) (Figure A2.9). Package of 2.0 m sandy siltstone (Fm), lateral to the prior one, reddish green, and plane parallel stratification. The presence of deformed sandstone blocks (Smm), within the clayish siltstone package at the top (Figure A2.10), indicates likely slump processes. It is close to contact with the basement.

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Figure A2.9 – Silty sandstone with current ripples (Ssp).

Figure A2.10 - Photo the outcrop with the deformed sandstone package (Smm).

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SITE 5

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	262396	7417508	666	1m	Córrego Alegre

Outcrop along the shoulder of Marechal Rondon Highway, 5 m high and 30 m long. It is constituted by layers of greyish yellow fine to medium sandstone (Sh), separated by a basal package of fine, tabular decimetric sandstone with siltstone levels, cut by channelized layers of coarse sandstone fining upwards (Figure A2.11). There are erosive features, with truncation, *onlap* and *downlap*, and current ripples at the top of layers with tabular cross stratification (Figure A2.12).

The erosive features at the base of the coarse sandstone indicate their hyperpycnal character, which is able to remove part of the layer over which it passes. The tabular geometry indicates that these sediments overflowed and spread out upon reaching the water body.

Figure A2.11 - Photo of the outcrop, showing truncating sandstone layers (Sh).

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Figure A2.12 - Photo of sandstone with ripples.

SITE 6

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	260800	7415354	631	1m	Córrego Alegre

Outcrop in a ravine above a railroad tunnel. It is constituted by red diamictite (Df), 4 m thick, with a silty-clayish matrix, and angular, spherical pebbles and granules of quartz and other lithic materials (Figure A2.13). There is a 3 m package of massive siltstone (Fm) with tabular geometry and diagenetic clay. The deposits suggest deposicional pulses associated with currents of different energies, in a distal basin setting.

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Figure A2.13 - Photo of the diamictite outcrop with clayish matrix (Df).

SITE 7

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	261145	7416182	648	1m	Córrego Alegre

Cut along the railroad right-of-way, in the Northern part of the area, 1 m high. Highly altered outcrop, composed of a massive, fine to very fine, light yellow sandstone package (Smm), limited at the top and base by millimetrically laminated, conchoidal siltstone layers (Fm) (Figure A2.14).

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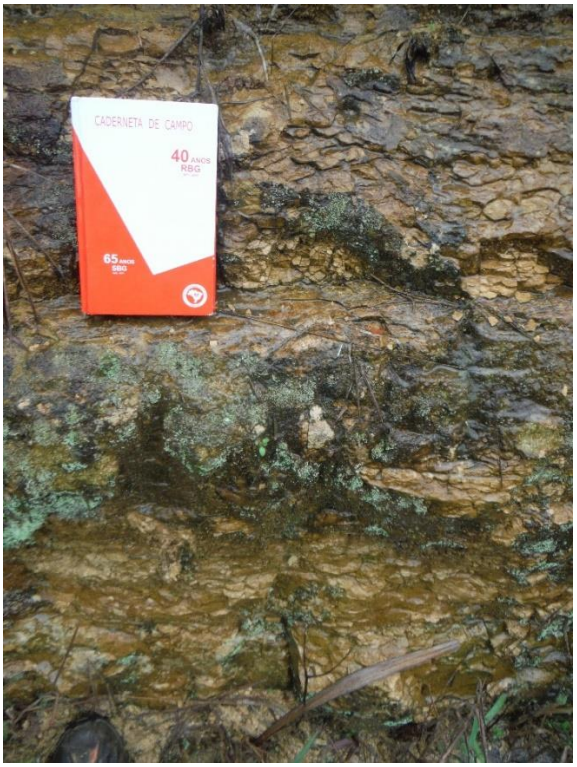

Figure A2.14 - Photo of the conchoidal siltstone outcrop (Fm).

SITE 8

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	260462	7411822	646	1m	Córrego Alegre

Outcrop along a dirt road cut, near the Nova União housing complex. Well altered, yellow, medium sandstone (Smm) (Figure A2.15), with indistinguishable internal structure. Area with a highly altered red layer, with some variation in grain size and/or composition.

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Figure A2.15 - Photo of a sandstone sample on the altered outcrop (Smm).

SITE 9

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	256972	7411768	596	1m	Córrego Alegre

Cut along Castelo Branco Highway, Km 83. Immature, highly altered rock, with a silty-clayish matrix and coarse grains. Its composition is heterogeneous, with clay intraclasts (Figure A2.16). It consists of a 1.5 m package of fine, reddish brown, massive and tabular sandstone with coarse sand grains and matrix (Smm), with claystone levels (Fm) (Figure A2.17).

Figure A2.16 - Hand sample of sandstone with clay intraclast (Smm).

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Figure A2.17 – Interbedding of claystone (Fm) and massive sandstone with matrix (Smm).

SITE 10

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	252157	7413664	638	1m	Córrego Alegre

Outcrop on a ravine along a dirt road. Laminated rhythmite (Rh), 1 m thick, composed of interbedded beige very fine sandstone and brown claystone (Figure A17a), with current ripples in the sandy portions, and tabular with deformation features (Figure A17b).

Brown, laminated and tabular mudstone (Sm). On top, a yellow, friable sandstone layer (Smm), massive and tabular, with grains of various mineralogy. It exhibits clay intraclasts.

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Figure A2.18 - Photo of rhythmite samples (Rh).

SITE 11

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	245897	7414238	646	1m	Córrego Alegre

Outcrop oriented SE-NW along cut on the road, on Presidente Castello Branco Highway, Km 84 (Figure A2.19). Beige siltstone (Fl), 3 m thick, homogeneous, laminated and tabular. There are fine, sandy lenses (Smm) (Figure 42), as well as black, millimetric surfaces of manganese oxide. The strata exhibit numerous fractures (S_o=25°/5°).

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Figure A2.19 - Photo of the outcrop with sandy lenses inside the siltstone (Smm / Fl).

SITE 12

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	246636	7411341	621	1m	Córrego Alegre

Outcrop along a cut in a street, in the parking lot at the back of the Technological Park, in Sorocaba. Beige siltstone (Fm) wall 2 m high with very fine sandstone interbedding (Smm) and a dark gray alteration cover. At the base, there is a very well-marked lamination, but towards the top, the packages become massive. The geometry is tabular, and there are slump fold features, indicating a West to East slump direction (Figure A2.20).

Figure A2.20 - Photo of the outcrop with folded layers due to a slump (Fm / Smm).

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SITE 13

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	251540	7411944	611	1m	Córrego Alegre

Outcrop along a cut on a dirt road, in Flor de Carvalho Street. It is composed of beige, tabular siltstone layers, centimetric at the top, with millimetric dark grey, clayish siltstone at the base (facies Fm) (Figure A2.21). All of the outcrop exhibits a pattern of vertical fractures with millimetric displacement and smooth surfaces, while others are conchoidal.

Figure A2.21 - Photo of the outcrop with the massive siltstone of facies Fm.

SITE 14

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	261962	7413327	666	1m	Córrego Alegre

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Slab outcrop on a bare field next to SP-075 highway. Reddish, highly altered polymictic diamictite (Df), massive, with clayish matrix, quartz grains and rock fragments. Facies is very similar to the diamictite of site 6 (Figure A2.22). Above, there is a yellow, highly altered siltstone layer (Fm). No structures are observable. Facies association is similar to that along the railroad right-of-way at site 6.

Figure A2.22 - Photo of the highly altered slab outcrop.

SITE 15

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	262005	7413859	628	1m	Córrego Alegre

Outcrop along abandoned quarry, near the prior site, still close to SP-075 highway. Yellow siltstone, 1 m thick, exhibiting poorly developed lamination and massive and tabular portions. Vertical fracture pattern with millimetric displacement and smooth surfaces, while others are conchoidal. Massive, grey clayish siltstone 1 m thick, no observable geometry, while fractures have a conchoidal pattern (Fm) (Figure A2.23).

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Figure A2.23 - Outcrop with conchoidal siltstone (Fm).

Pink claystone (Fm) with red alteration cover and decimetric layers, some massive and tabular, with rare dispersed quartz grains in sand grain size. It exhibits centimetric, yellow, massive, fine sandy lenses (Smm) (Figure A2.24).

Figure A2.24 - Photo of the outcrop with pink claystone (Fm) and massive sandstone lens (Smm).

SITE 16

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	260959	7413642	633	1m	Córrego Alegre

Outcrop along a ditch in a dirt road, next to the quarry of site 15. Yellowish beige siltstone (Fm) cycles, with sandy fraction composed of quartz grains (Figure A2.25), feldspar and opaque minerals, massive and tabular (Smm), which exhibits a conchoidal fracture pattern throughout the outcrop; and massive, tabular reddish pink claystone (Fm) with quartz grains.

Figure A2.25 - Outcrop with pink claystone and conchoidal siltstone interbedding, with sandstone levels.

SITE 17

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	260570	7413551	615	1m	Córrego Alegre

Outcrop along the same dirt road as site 16. Control point, indicating the same lithofacies throughout the roadbed, constituted by a yellowish beige siltstone (Fm) with conchoidal fractures (Figure A2.26).

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Figure A2.26 - Photo of the conchoidal siltstone outcrop (Fm).

SITE 18

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	260354	7413282	619	1m	Córrego Alegre

Outcrop in the same dirt road as in site 16. This point was checked as a control of the continuity of the conchoidal siltstone (Fm) facies (Figure A2.27), which continues to outcrop along the road.

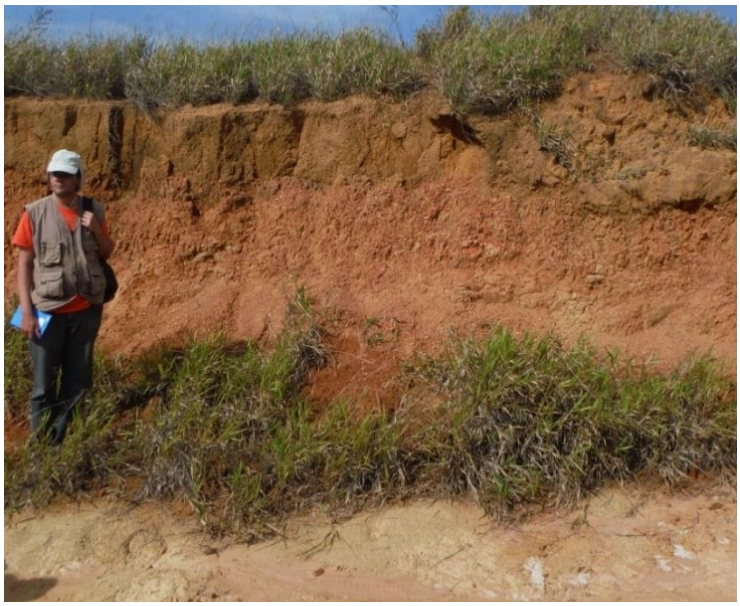

Figure A2.27 - Outcrop with conchoidal siltstone (Fm).

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SITE 19

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	258817	7414618	639	1m	Córrego Alegre

Set of two quarries with the same exploration. Yellowish beige basal siltstone (Fm) package, similar to that seen on the prior sites, with tabular external geometry and massive structure. There is a 4 m alternating sequence of that siltstone with greyish green, well laminated, centimetric shale (Fl) with tabular geometry and much clay (Figure A2.28). Each layer is of centimetric thickness and exhibits manganese oxide levels, which is a post-depositional feature.

Figure A2.28 - Photo of the clayish shale outcrop (Fl).

This alternating sequence is interrupted by a fine, tabular, massive, continuous, reddish brown sandstone (Smm) layer (Figure A2.29), with undulated top and base. This sandstone is well sorted and immature, with quartz and feldspar grains and zones with higher concentration of opaque minerals. This sequence continues until the next quarry. The alternating sand and silt layers indicate depositional processes associated with periods of higher and lower energy.

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Figure A2.29 - Hand sample of the massive sandstone (Smm).

SITE 20

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	253926	7411917	627	1m	Córrego Alegre

Outcrop along a cut approximately 1.5 m high, in a dirt road. Grey diamictite (Dm) approximately 0.8 m thick, with an immature, heterogeneous, grey sandy matrix and various rounded and/or angular pebbles and granules. There is a sharp contact with a different diamictite (Df) (Figure A2.30), with a clayish, greyish yellow matrix and well-rounded but fewer granules and pebbles. The general external geometry of the cut is tabular, but internally massive (Figure A2.31). It can be inferred that the pebbles of different sizes came from a glacier. The layers exhibit undulations, possibly caused by the flow that originated them.

Figure A2.30 – Difference between the clayish diamictite (greyish yellow) (Df) and the sandy diamictite (grey) (Dm).

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Figure A2.31 - Photo of the sandy diamictite outcrop (Dm).

SITE 21

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	254530	7410415	566	1m	Córrego Alegre

Cut along a road parallel to the outcrop at site 20. Alternating claystone (Fm) and shale (Fl) (Figure A2.32), with facies similar to those of the quarry. However, in this case, the claystone layers are below the shale layers.

Figure A2.32 – Outcrop of clayish shale (Fl).

SITE 22

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	255815	7412108	576	1m	Córrego Alegre

Outcrop located along Presidente Castelo Branco Highway, at Km 84. Ravine 2 m thick, containing massive and tabular reddish pink claystone (Fm). There are also decimetric dark grey, heterogeneous, fine sandstone (Smm) layers, with quartz and feldspar matrix and grains (Figure A2.33). Alternating layers similar to those of site 9.

Figure A2.33 - Claystone layers (Fm) with a sandstone intercalation (Smm).

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SITE 23

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	255713	741222	587	1m	Córrego Alegre

Outcrop located in a waterfall, in Fazenda Cajuru, at Km 84 of Presidente Castelo Branco Highway (Figure A2.34). This outcrop is stratigraphically related to the prior site, located below it, and composed of dark yellow sandstone (Smm), 3 m thick, with coarse sand grains and matrix, but essentially constituted by fine, massive, tabular sand (Figure A2.35*)*. The sediment grains exhibit poor sorting and maturity, and have varied mineralogy.

Figure A2.34 - Photo of the outcrop, showing tabular sandstone layers (Smm).

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Figure A2.35 – Hand sample of fine, massive, immature sandstone, with matrix (Smm).

SITE 24

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	256138	7413181	583	1m	Córrego Alegre

Slab outcrop 2 m high, located near Fazenda Cajuru, along a cut in a dirt road, close to a drainage ditch. This outcrop is constituted by layers of massive sandstone (Smm) and grey, clayish siltstone (Fl) (Figure A2.36).

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Figure A2.36 - Photo of the outcrop with layers of sandstone (Smm) and clayish siltstone (Fl).

SITE 25

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	255897	7412982	591	1m	Córrego Alegre

Slab outcrop, located near Fazenda Cajuru, following the drainage above, from the prior site. This outcrop consists of a 3 m thick alternating sequence of fine massive sandstone (Smm), seen at site 23, with grey, clayish siltstone (Fl) (Figure A2.37). In some portions, this alternating sequence occurs in a disorganized fashion, with discontinuous layers and sandstone lenses inside the siltstone, which generally lies above. There is also a vertical fracture pattern throughout the slab extension (inclination = 310°/90°).

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Figure A2.37 – Sandstone lenses inside the clayish siltstone (Smm / Fl).

SITE 26

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	250910	7414028	629	1m	Córrego Alegre

Slab outcrop located at the head of the drainage, inside a ranch, near Presidente Castelo Branco Highway. This outcrop is constituted by alternating siltstone (Fl) and sandstone (Smm) in a drainage ditch (Figure A2.38).

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Figure A2.38 – Outcrop of conchoidal siltstone (Fm) alternating with fine, massive sandstone (Smm).

SITE 27

Coordinates					
UTM Zone	X Axis	Y Axis	Altitude (m)	Error	Datum
23K	250740	7414213	606	1m	Córrego Alegre

Slab outcrop along drainage ditch, topographically below the prior site, near a dam. The cut has a N-S orientation; to the south, there are layers of fine to medium, immature and poorly sorted sandstone (Smm); to the North, there is a variation of that same sandstone (Gp), with pebbles, becoming conglomeratic (Figure A2.39). The levels above are interbedded with yellowish siltstone (Fl). The top is a massive package of the same sandstone as at the base, indicating the start of a new cycle.

The presence of conglomeratic layers places the package in a proximal environment, becoming more distal towards the South. The preservation of clay intraclasts and of the siltstone within the sandstone indicates that the flow was capable of eroding or removing material already deposited.

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Figure A2.39 – Outcrop of conglomeratic sandstone (Gp).