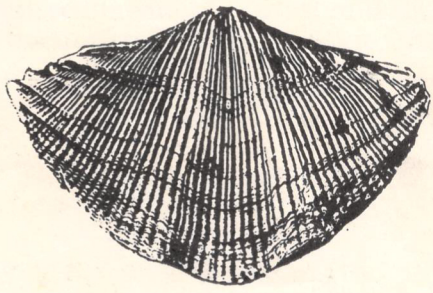
INTERNATIONAL SYMPOSIUM ON THE CARBONIFEROUS AND PERMIAN SYSTEMS IN SOUTH AMERICA



ACADEMIA BRASILEIRA DE CIÊNCIAS
INSTITUTO DE GEOCIÊNCIAS, USP
SÃO PAULO
BRASIL
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SECOND DAY — NOVEMBER 26 th

Sorocaba to Ponta Grossa
Guide: A. C. Rocha-Campos

Road-log prepared by: A. C. Rocha-Campos, M. E. C. B. de Oliveira, P. R. dos Santos and A. R. Saad.

Towards southern São Paulo a reworked moraine facies (mud--flow) predominates in the Itararé Subgroup. Diamictites generally include numerous bodies, masses and disrupted lenses or beds of sandstone, many plastically deformed. Strata interpreted as ground moraines also occur (Frakes and Figueiredo, 1967).

Sandstone predominates at the base of the section near Sorocaba and at the top of the Itararé Subgroup in the vicinity of Itapetininga.

The section is remarkable for the repetitive appearance of set of lithologies (Leinz, 1937; Frakes and Figueiredo, 1967). At least four rock types may constitute the local cycles (Frakes and Figueiredo, 1967):

Sandstone
Interbedded sandstone and shale or varve-like strata
Mudstone or pelodite
Diamictite.

The cycles are, however, often incomplete probably due to subsequent erosin (Frakes and Figueiredo, 1967). (Fig. 13.)

Near Itapetininga the contact between the Tubarão Group (Tatuí and Taquaral members of the Itapetininga Formation) and the overlying Irati Formation will be directly observed. An erosional surface seems to separate the Taquaral from the Tatuí.

Sandstone is the major contituent of the Tubarão Group (including Itararé Subgroup) in the Itapetininga area.

Towards the south the diamictites to be examined are either massive or may contain deformed sandstone inclusions. Channel-like and wedge-shaped sand bodies included in one of the diamictites were interpreted as subglacial eskers and pseudomorphs of ice-wedges and so, a glacial origin for the diamictites in the area was reinforced (Frakes et al., 1969).

Departure time:	7:00 A.M.
Km 97.3 (SP-270)	Junction with road to Itapetininga. Turn right (south).

Km 115

Entrance to Araçoiaba to the right. View of the Serra de Araçoiaba in the background, an alcalic intrusion into the Late Paleozoic sediments.

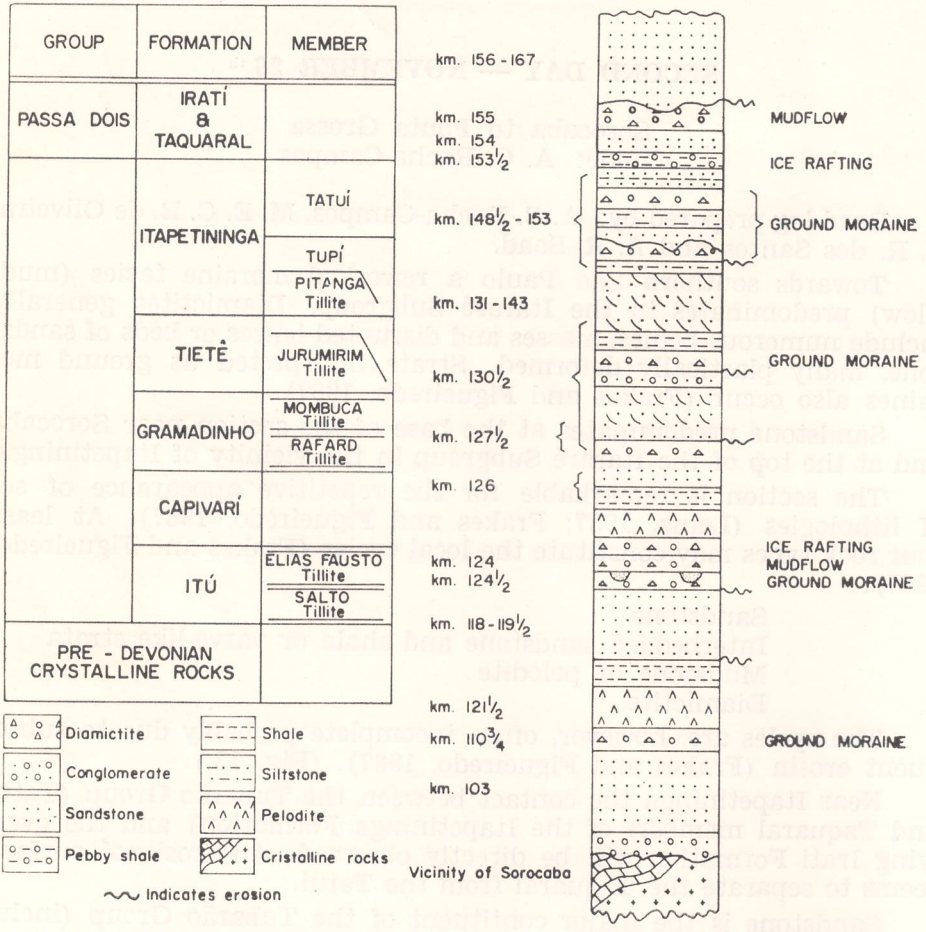

Fig. 13 — Itararé rocks outcropping along the Sorocaba — Itapetininga road (Frakes and Figueiredo, 1967).

Km 122

Stop for 20 minutes.
Massive to poorly stratified, bright to medium gray siltstone of the Itararé (pelodite or mudstone), with numerous centimetric, discoidal calcareous concretions bearing fish remains, carbonized fragments and thin interbeds of fine, yellowish sandstone.

Fig. 14 —Massive siltstone or mudstone (pelodite) of the Itararé Subgroup. Road Sorocaba-Itapetininga (SP-270, km 121.1).

Km 122.3 — Excellent outcrop of same lithology showing discontinuous calciferous bands (Fig. 14).

Km 122.8 — Massive or poorly stratified mudstone (pelodite) of the Itararé Subgroup.

Km 123.8 — **Stop for 15 minutes.**
Bright-gray, sandy diamictite of the Itararé Subgroup with evidences of stratification overlying discordantly a bed of mudstone. On the right side of the road the diamictite contains small inclusions of calciferous sandstone. Contorted masses, "balls" and lenticular inclusions of sandstone are common in the pelodite, which shows faint evidence of stratification. Enormous mass of sandstone (6-7 meters of diameter), contorted internally, occurs at north side of the western road cut, immersed into the mudstone.

Km 124.8 **Stop for 15 minutes.**
Light-gray, sandy diamictite is overlain by yellowish sandstone outcropping on left side of road. The diamictite contains numerous lenses or masses of sandstone or conglomeratic sandstone. One of the larger sandstone bodies is poorly sorted, with numerous clay-pebbles, while the other is stratified and contains inclusions of diamictite and clay-pebble conglomerate at the base.

Km 125.8 Rhythmic alternation of beds, laminae or lenses of sandstone and bright-gray siltstone (Itararé Subgroup). Micro-cross-lamination appears in the sandstone. Internal deformed beds may be seen.

Km 127.5 **Stop for 10 minutes.**
Medium-gray, sandy diamictite with lenses, disrupted beds and spherical or ellypsoidal masses of coarse to conglomeratic sandstone is discordantly overlain by beds of fine, well-sorted, yellowish, cross-bedded sandstone. Diamictite is better exposed on the right side of the road, while the sandstone appears well exposed on the left.

Km 128 **Stop for 20 minutes.**
Light-gray, sandy diamictite of the Itararé with numerous interbeds of lenses, spherical masses and dikes of sandstone overlies discordantly a very fine, cross-bedded sandstone (same as in last stop) on the left side of the road. The contact between the two units is better shown on the right side.

Km 128.9 Entrance to Capela do Alto and Tatuí.

Km 130.5 Weathered, reddish and yellowish sandstone overlying a diamictite (Itararé Subgroup).

Km 131 Thick cross-bedded sandstone bodies (Itararé Subgroup).

Km 135.5 Thick sandstone bodies; cross-bedded.

Km 138.4 **Stop for 15 minutes.**
Yellowish and whiteish, fine to medium, well sorted sandstone interstratified with

greenish-gray, well laminated siltstone of the Itararé Subgroup. Clay-pebble conglomerates occur at the base of sand units (of thickness varying from a few decimeters to 1.5 meter), which may form small channel. Cross-bedding appears in the sandstone.

Km 138.8 — Interbedded, yellowish, reddish sandstone and siltstones of the Itararé Subgroup.

Km 142.4 — Entrance to Sarapuí.

Km 142.9 — Yellowish and reddish sandstone and siltstones of the Itararé Subgroup.

Km 148.5 — **Stop for 20 minutes.**
Stratified sandstone and siltstone "intruded" by masses of massive siltstone (mudstone or pelodite) of the Itararé Subgroup. Numerous small faults form the contact between mixed lithologic bodies. A thin weathered diabase sill is intruded in the lower part of the sequence.

Km 150.7 — Siltstone and sandstone of the Itararé.

Km 151.2 — Greenish-gray, massive diamictite intercalated with sandstone (Itararé Subgroup).

Km 151.9 — Light-gray, sandy diamictite with abundant interbeds of sandstone (lenses, dikes and disrupted bodies).

Km 152.7 — Thick bedded, yellowish sandstone (Itararé Subgroup).

Km 153.6 — Sandstone and gray shales (Itararé Subgroup).

Km 154 — Massive, reddish sandstone of the Itararé Subgroup.

Km 155 — Gray, sandy diamictite of the Itararé Subgroup.

Km 158.4 — Junction with road to Tatuí (SP-127). Turn right.

Km 136 (SP-127) — Weathered shales and dolomites of the Irati Formation.

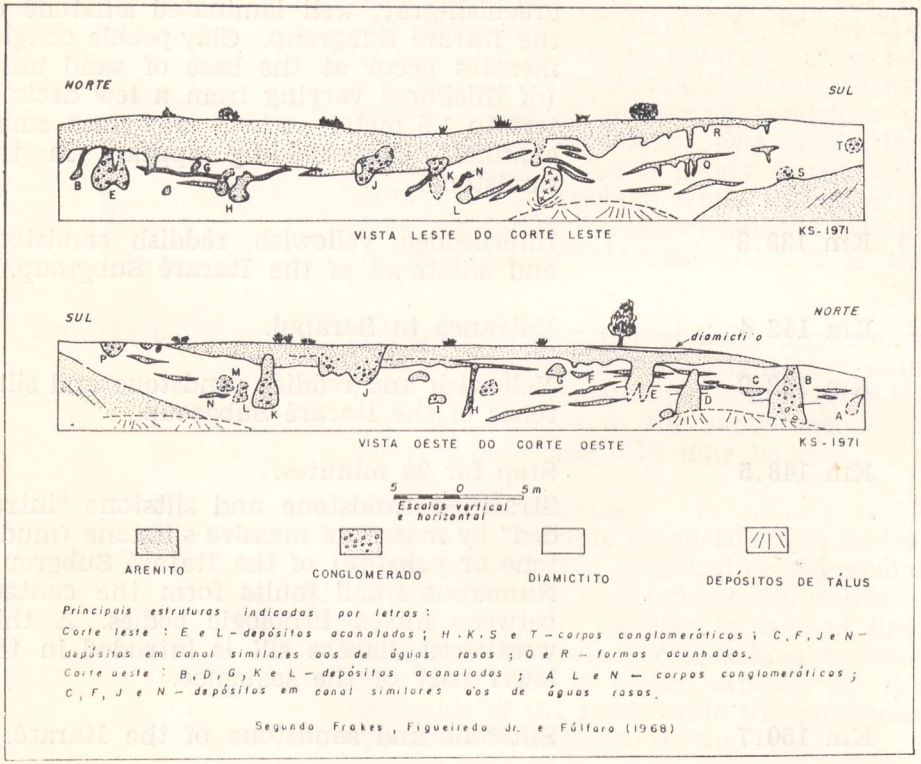

Fig. 15 — Channel-like and wedge-shaped sandstone and conglomerate bodies interpreted as fossil eskers and crevasse fillings outcropping or road cuts south wards from Itapetininga (SP-270, km 167.1). (From Frakes et al., 1968.)

Km 135.5

Stop for 30 minutes.

Excellent exposure of the upper part of the Tubarão Group (Tatuí and Taquaral members) overlain by interbedded black, bituminous shale and dolomite of the Irati Formation (lower-most unit of the Passa Dois Group, Permian). The Tatuí is represented by bright-gray, poorly stratified, fine sandstone and siltstone, and the Taquaral is composed of bright to medium-gray shale. The contact between the Tatuí and Taquaral is marked by an abrupt lithological change. A conglomerate with chert nodules and fish teeth occurs at the contact (disconformity?). The irregular contact between the Irati and the Taquaral

is due to weathering and differential compaction of calcareous beds.
From this point the excursion will return to the main road (SP-270), and proceed towards, Curitiba (overnight stop), via Itapetininga, Itararé and Ponta Grossa.

Km 163.4 — Entrance to Itapetininga.

Km 167.1 — **Stop for 30 minutes.**
Possible eskers and pseudomorphs of ice wedges cutting brigh, yellowish-gray, sandy diamictite of the upper part of the Itararé Formation (Gramadinho Formation) outcropping on both sides of road cut. Striated clasts are common in the diamictite (Fig. 15).

Km 176.4 — **Stop for 15 minutes.**
Thick outcrop of medium gray, non-stratified Gramadinho diamictite, with abundant clasts, on the left side of the road.

Km 177 — Dark-gray shale of the Itararé Subgroup.

Km 331 — Road to Itaporanga to the right.

Km 354.8 — Entrance to Itararé, type area of the Itararé Subgroup.

Stop for lunch - 60 minutes.

Km 355 — Canyon of the Itararé River, carved on Devonian sandstone Furnas sandstone.
State border.

Km 362.7 — **Stop for 20 minutes.**
Dark-gray, sandy diamictite of the basal part of the Itararé Subgroup outcropping on both sides of the road. Numerous dykes and concordant, subparallel lenses of fine to coarse sandstone form a channel-like structure at the middle part of outcrop. Disrupted large sandstone balls with folded bedding may be seen at the southern part of the outcrop (Fig. 16).

From this point the excursion will proceed directly to Curitiba, via Ponta Grossa, for overnight stop. From now on excursionists may observe the beautiful exposures of Devonian Furnas sandstone with conspicuous

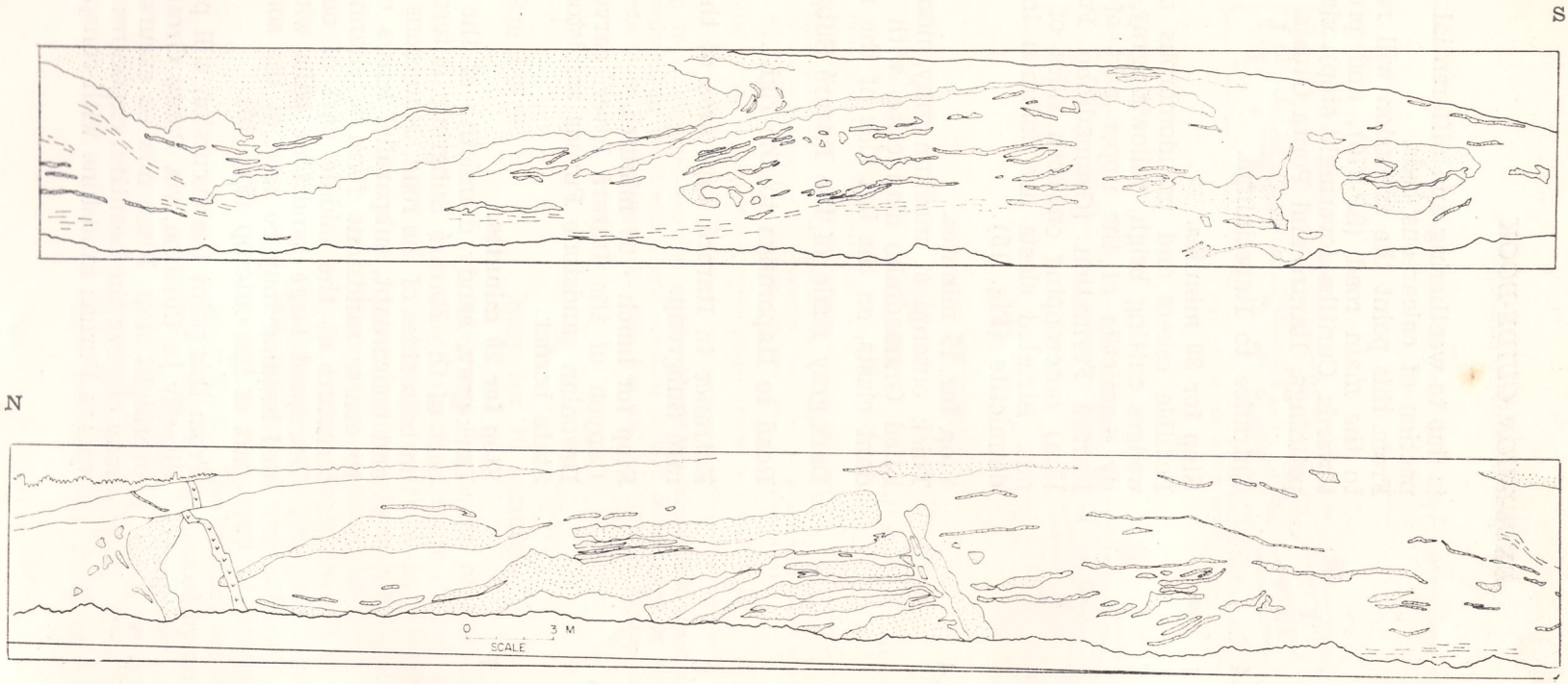

Fig. 16 — Diamictite with numerous inclusion of sandstone lenses and dykes, some disrupted and folded. Note channel-like deposit of sandstone at the middle part of the eastern cut. Explanation: blanck; diamictite; dotted: sandstone; interrupted lines: stratification; «V» = diabase dyke; coarse lower line is upper limit of tallus. Road Itararé-Ponta Grossa, km 362.7.

cross-bedding. The road ascends to the second plateau of Paraná.

Km 367.8 **Stop for 15 minutes.**
Dark gray diamictite of the lower Itararé Subgroup.

THIRD DAY — NOVEMBER 27th

Curitiba to São Mateus do Sul

During the morning the party will proceed directly to São Mateus for a visit to the oil-shale prototype plant operated by Petrobrás. Superintendência da Industrialização do Xisto. Geological observations will be made in the afternoon on the way back to Curitiba.

Morning Program

Guides: C. L. Alves (Petrobrás - SIX)
V. T. Padula (Petrobrás - SIX)

Program for São Mateus prepared by C. L. Alves and V. T. Padula.

7:00 A.M. Departure from Curitiba.
8:30 A.M. Arrival at São Mateus. Cofee break.
9:00 A.M. Lecture on aspects of oil-shale industrialization by Eng. Carlos Egydio Bruni, Superintendent, Petrobrás - SIX.
10:30 A.M. Visit to oil-shale experimental mine. Outcrops of the upper part of the Irati Formation showing beautifully the typical southern facies of the formation with predominance of shale. Remains of the reptile **Mesosaurus brasiliensis** McGregor may be collected.
12:00 A.M. Visit to oil-shale plant.
12:30 P.M. Barbecue offered by Petrobrás - SIX.

Technical and economical results already obtained at laboratory, mine and pilot scales led Petrobrás to install at São Mateus do Sul, State of Paraná, the Usina Protótipo do Irati (UPI), in which processing of oil shale is made at industrial dimensions.

In order to reach the objectives of this last experimental phase, the UPI is equipped to process up to 2,200 tons per day of oil-shale extracted from its experimental mine, resulting in 160 cubic meters (1,000 barrels) of oil, 36,500 cubic meters of gas and 17 tons of sulphur.

Oil shale beds economically exploited correspond to two zones separated by a middle barren horizon, stratigraphically situated at the upper part of the Irati Formation, immediately below the contact with shales of the Serra Alta Formation.

These beds will be examined along about 600 meters at the experimental mine, according to the following scheme (from top to bottom):

4) **Cover** — Slightly weathered Serra Alta shales. Average thickness: 5.5 meters.
3) **Upper shale beds** — Dark brown to black, pyrobituminous, well laminated shales, with frequent calcareous concretions.