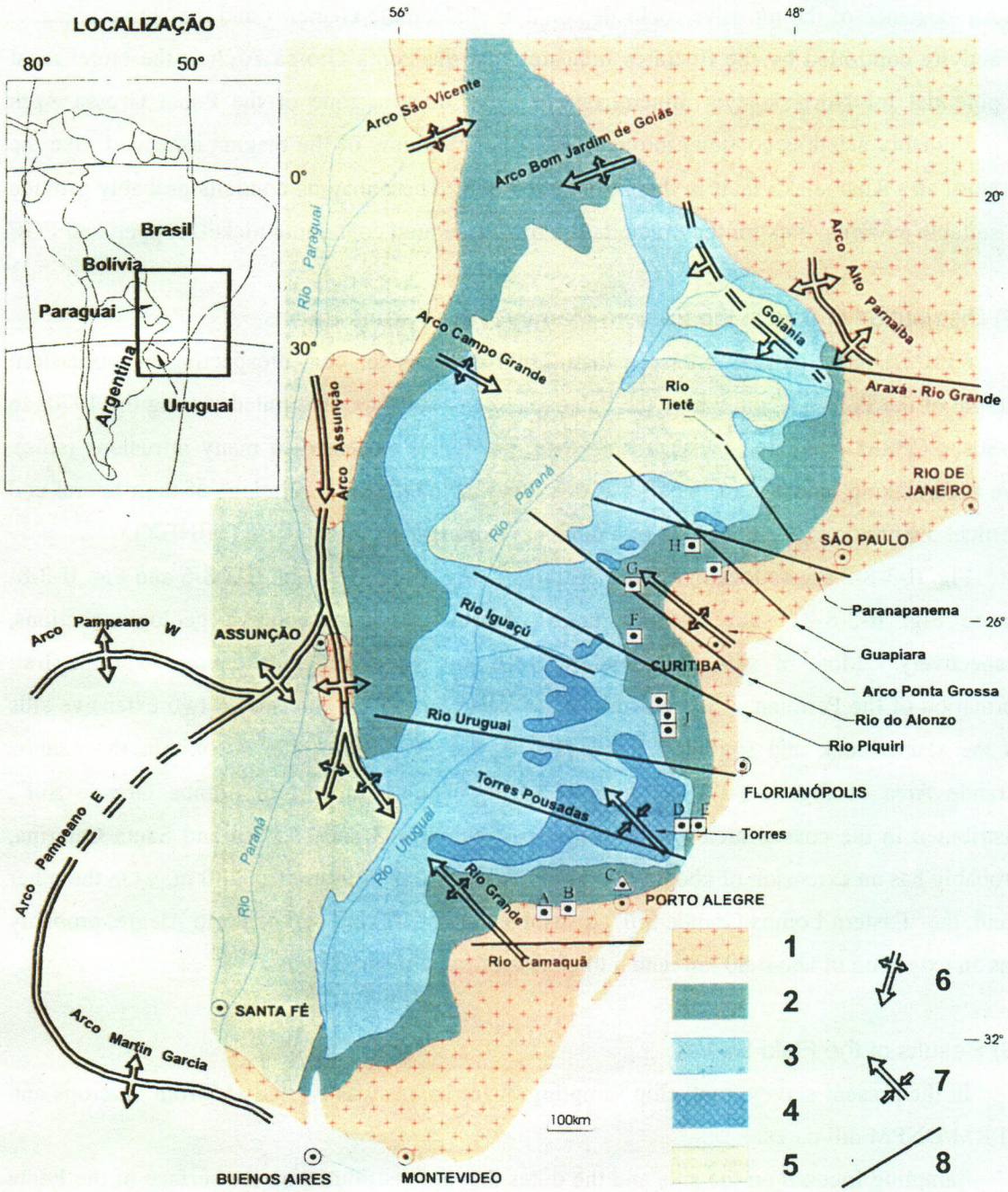
3-8 Magmaic Activity in the Eastern Margin of the Paraná Basin and its Relation to PGE

3-8-1 Intrusions in the Eastern margin of the Paraná Basin

(1) Overview of the Cooperative Survey Program of Canada and Brazil

Canada and Brazil in their cooperative survey program studied geochemical characteristics of the intrusive rocks distributed in the eastern margin of the Paraná basin. Fig. II-3-8-1 shows the survey area. Their survey can be summarized as follows:

1) The petrochemical survey focused on the intrusive rocks distributed in the eastern margin of the Paraná basin from São Paulo in the northern part to Porto Alegre in the southern part of the basin. The survey aimed to evaluate probable mineralization of the Noril'sk style nickel-copper-PGE ore associated with intrusive rocks relating to the flood basalts.
2) Except for some depleted rocks, the flood basalts (lavas and intrusions) in the Paraná basin indicate high background values of Pt and Pd as the flood basalts in the other regions.
3) Like the lavas, the intrusions are classified into "High-Ti" type and "Low-Ti" type, which are respectively distributed in the northern part and in the southern part of the basin. The ratios of trace elements reveal that the "High-Ti" type magma and the "Low-Ti" type magma were generated from mantle materials of similar compositions in their different degrees of partial melting.
4) The most primitive rocks (MgO = 18.26 wt%) were found in the Lomba Grande Complex of the southern part and from the Porto Alegre metropolitan region to the Iruí-Leão area, whereas the most fractionated and MgO poor rocks were found in the Ponta Grossa Arch of the northern part.
5) Regarding the olivine rich intrusions in the southern part of the Paraná basin, cumulative olivine fractionation presumably played the important process in the early to middle stages of crystallization history, forming similar association found in the Noril'sk region. However, as a group these olivine rich intrusions reveal no combination of trace elements suggesting the depletion of chalcophile elements and the crustal contamination. No regional fissure/lineament, which acted as a major magma conduit, were observed.
6) Meanwhile, most of the rocks were found depleted in chalcophile elements in the sills of the Ponta Grossa Arch in the northern part of the Paraná basin. These rocks also suggest crustal contamination. Although chalcophile elements were observed depleted in the sills, no depletion of the elements was recognized in the dikes, which might have acted as conduit of the flood basalts. Depletion of chalcophile elements was also observed in some limited rocks of the intrusions in the southern part of the basin.



Esboço Geológico da Bacia do Paraná (modificado de Melfi et al, 1988): 1 Embasamento cristalino pré-devoniano; 2 Sedimentos pré-vulcânicos-dominantemente paleozóicos; 3 Lavas vulcânicas intermediárias e básicas; 4 - Derrames estratificados de lavas ácidas; 5 Sedimentos pós-vulcânicos (principalmente do Cretáceo Superior); 6 Estrutura tipo arco; 7 Estrutura tipo sinclinal; 8 Lineamento tectônico e/ou magnético. Sills ⊡ ; intrusão hipoabissal ◬ ; A: região de Iruí- Leão-PA; B: região de Rio Pardo-PA; C: Lomba Grande-LG; D: Sill de Maracajá/Barro Branco-MB; E: Corpo Básico de Rio Urussanga-RU; F: Sill de Irati-PGA; G: Sill de Reserva-PGA; H: Sills de Siqueira Campos-PGA; I: Sill de Fartura-PGA; J: Corpo Básico de Pouso Redondo/Rio do Campo-PRR.

Fig. II-3-8-1 Intrusions studied by the Canada-Brazil cooperative project

7) An existence of the intrusive rocks depleted in chalcophile elements and the active volcanic activity controlled by the fractures indicates that the Ponta Grossa Arch is the target most potential for Noril'sk style mineralization. The fracture zone of the Ponta Grossa Arch presumably acted as conduits through which large volume of the magma ascended, like the Noril'sk - Kharaelakh fault in the Noril'sk region. These magma conduits probably provide suitable environments for the precipitation of sulfide melt containing nickel, copper, and PGE.

(2) Distribution of Sills in the Eastern Margin of the Paraná Basin

CPRM/DNPM carried out more than 2,000 drillings for coal prospecting in the eastern margin of the Paraná basin, where the Paleozoic formations are distributed, during the 1970s to 1980s. CPRM integrated these drilling data, indicating existence of many intrusions (sills). We tried making database of the sills in this area, including the revelations of their lateral and vertical distributions, with the help of a mine development support system (MINEX).

Fig. II-3-8-2 shows location of the drillings. Fig. II-3-8-3 to Fig. II-3-8-6 and Fig. II-3-8-11 to Fig. II-3-8-21 show isopack maps of sills and representative geologic sections, respectively. Most of sills are found intruded into the formations deeper than the Irati formation of the Permian. Some drillings are assumed to have intersected two extensive sills in the south block and southeast block (Fig. II-3-8-2). These sills are within the Lomba Grande Area of Fig. II-3-1-1 and Fig. II-3-2-1. The "Northeastern Lomba Grande Sill", distributed in the coastal area on the border between Rio Grande do Sul and Santa Catarina, probably has an extension of about 180 km^2 and a thickness of more than 130 m. On the other hand, the "Eastern Lomba Grande Sill", distributed about 100 km east of Porto Alegre, probably has an extension of about 80 km^2 and a thickness of more than 130 m.

(3) Results of the Field Survey

In the present survey, rock chip sampling of intrusions was carried out from outcrops and CPRM/DNPM dill cores.

Sampling focused on the sills and the dikes that are distributed on the surface of the Ponta Grossa Arch in the northern part of the survey area. In the southern part of the survey area (Lomba Grande Area), core sampling focused on the sills from the nine drill cores. Besides nine cores, two samples of dikes penetrating the flood basalt were collected from outcrops. Fig. II-3-2-1 shows sampling positions. Table II-3-8-1 lists the samples. The specifications of the chemical analysis stand the same as that of lavas.

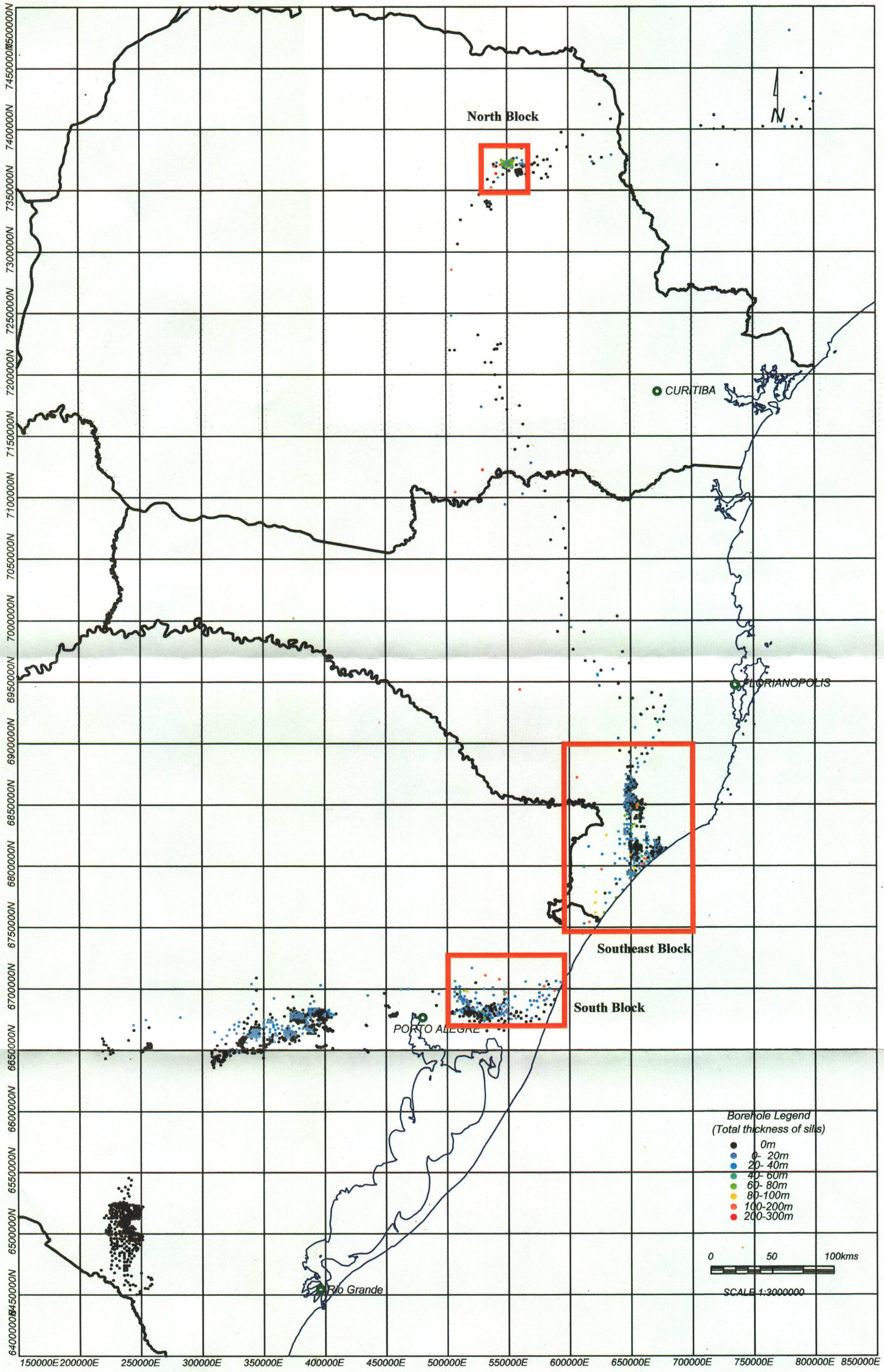


Fig. II-3-8-2 Borehole locations

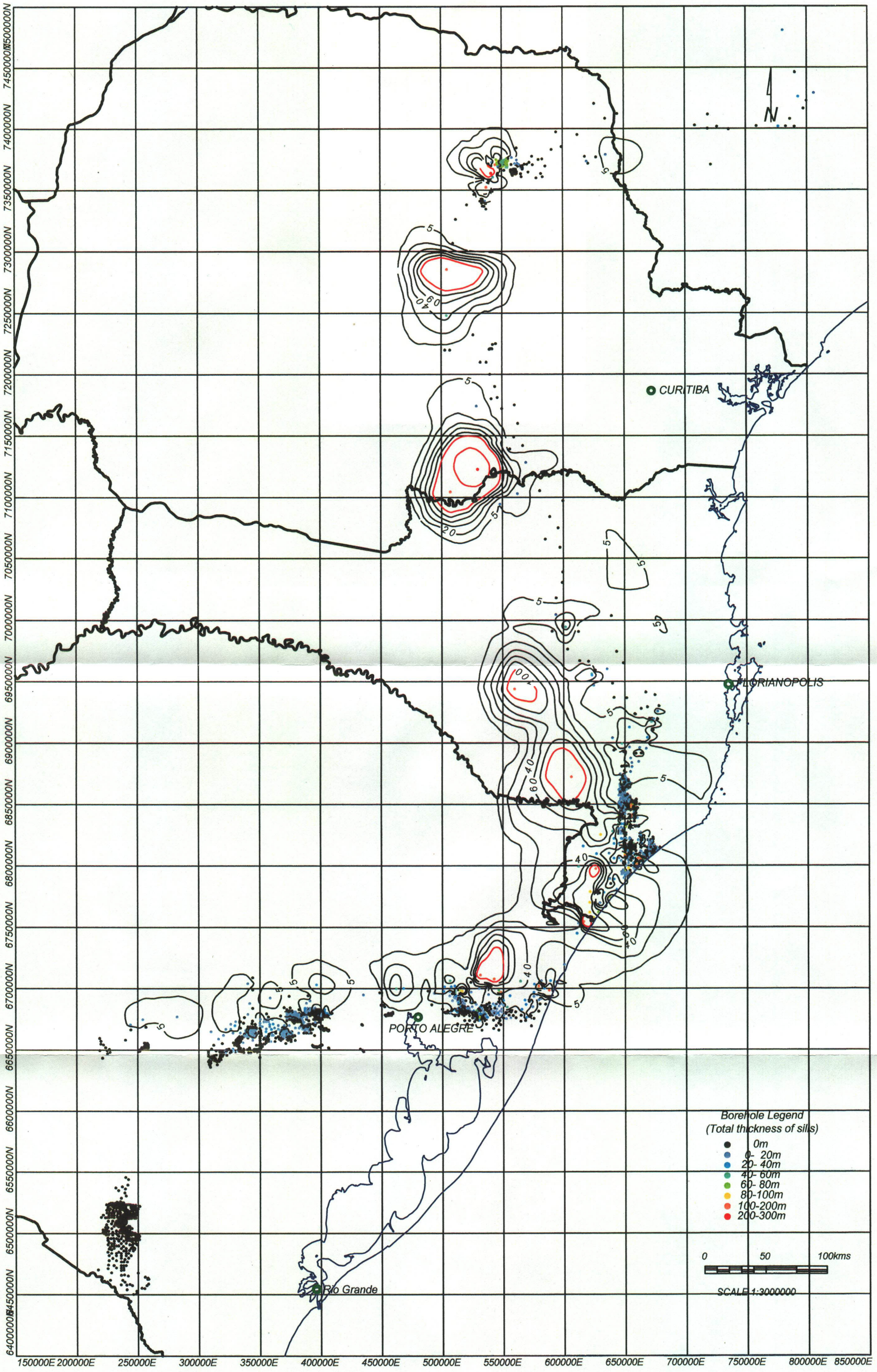


Fig. II-3-8-3 Isopach of total thickness of sills

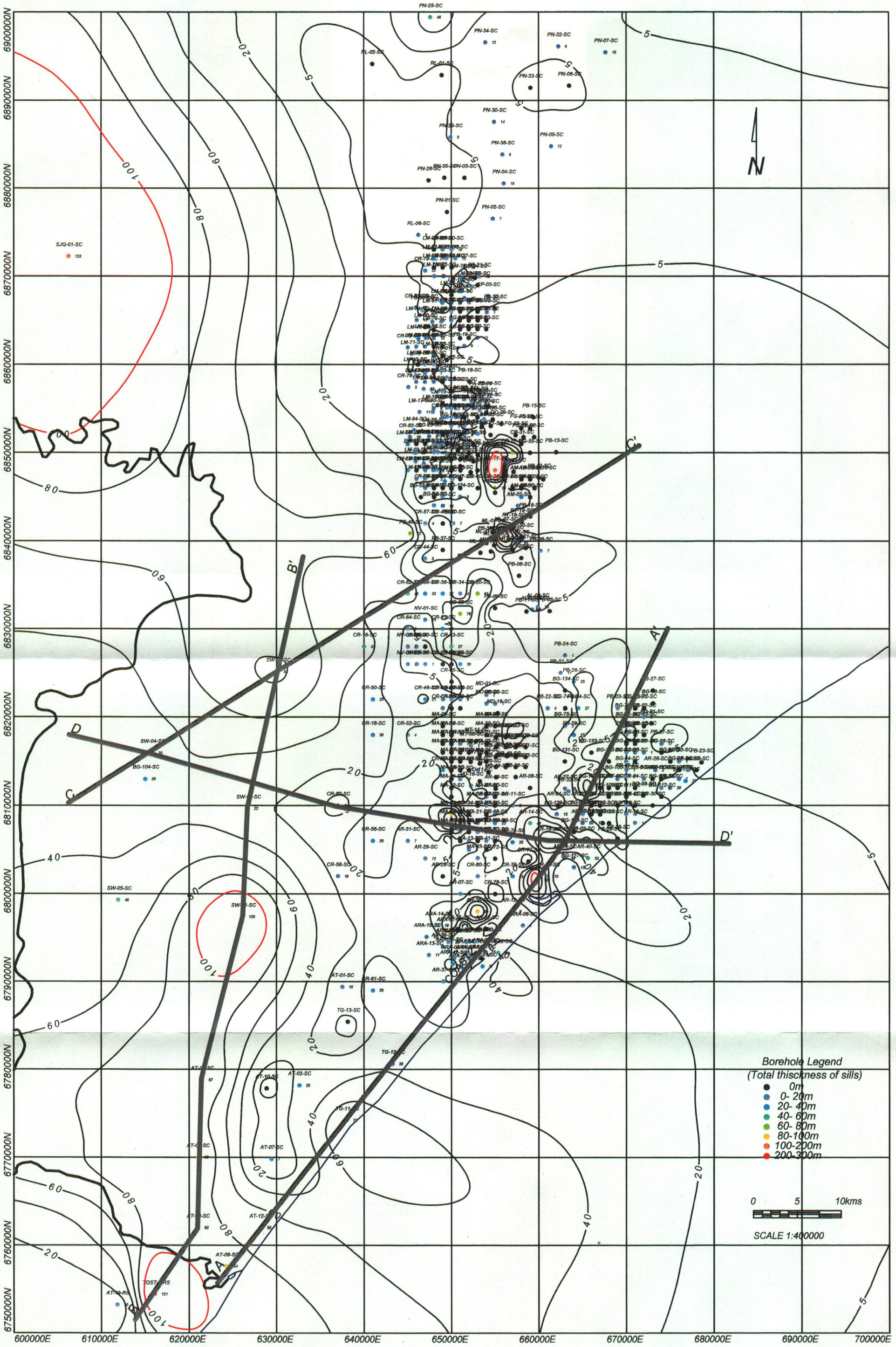


Fig. II-3-8-4 Isopach of the southeast block

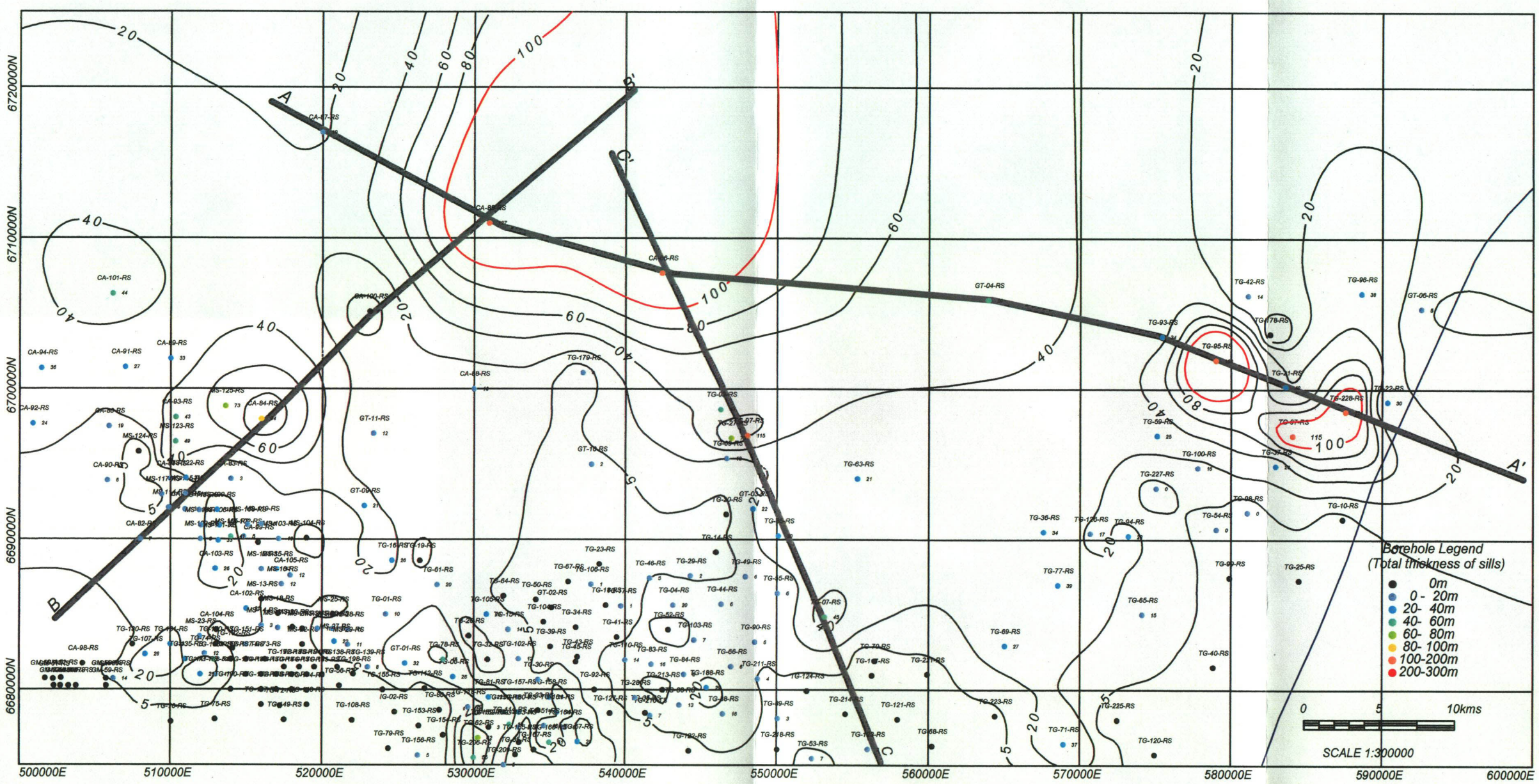


Fig. II-3-8-5 Isopach of the south block