Int J Earth Sci (Geol Rundsch) (2011) 100:543–569
DOI 10.1007/s00531-010-0604-4

ORIGINAL PAPER

The Itajaí foreland basin: a tectono-sedimentary record of the Ediacaran period, Southern Brazil

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Received: 8 April 2010 / Accepted: 5 September 2010 / Published online: 21 October 2010

Abstract The Itajaí Basin located in the southern border of the Luís Alves Microplate is considered as a peripheral foreland basin related to the Dom Feliciano Belt. It presents an excellent record of the Ediacaran period, and its upper parts display the best Brazilian example of Precambrian turbiditic deposits. The basal succession of Itajaí Group is represented by sandstones and conglomerates (Baú Formation) deposited in alluvial and deltaic-fan systems. The marine upper sequences correspond to the Ribeirão Carvalho (channelized and non-channelized proximal silty-argillaceous rhythmic turbidites), Ribeirão Neisse (arkosic sandstones and siltites), and Ribeirão do Bode (distal silty turbidites) formations. The Apiúna Formation felsic volcanic rocks crosscut the sedimentary succession. The Cambrian Subida leucosyenogranite represents the last felsic magmatic activity to affect the Itajaí Basin. The Brusque Group and the Florianópolis Batholith are proposed as source areas for the sediments of the upper sequence. For the lower continental units the source areas are the Santa Catarina, São Miguel and Camboriú complexes. The lack of any oceanic crust in the Itajaí Basin suggests that the marine units were deposited in a restricted, internal sea. The sedimentation started around 600 Ma and ended before 560 Ma as indicated by the emplacement of rhyolitic domes. The Itajaí Basin is temporally and tectonically correlated with the Camaquã Basin in Rio Grande do Sul and the Arroyo del Soldado/Piriápolis Basin in Uruguay. It also has several tectono-sedimentary characteristics in common with the African-equivalent Nama Basin.

Keywords Dom Feliciano Belt · Ediacaran · Foreland basin · U–Pb SHRIMP ages · Provenance

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Introduction

The best record of the transition between the collisional events that culminated with the constitution of the western Gondwana (end of the Ediacaran) and the stable conditions that enabled the installation of the Paraná Basin (Lower Paleozoic) is found in the northern portion of southern Brazil, in a series of sedimentary and volcano-sedimentary basins that do not show the deformation and metamorphism that characterize the units in the adjacent fold belts.

Among the existing Neoproterozoic basins (the Itajaí, Camarinha, Corupá, Campo Alegre, Guaratubinha, and Castro basins) can be divided into two major groups: foreland and extensional basins (continental rifts): The Camarinha and Itajaí basins, which are predominantly sedimentary and situated at the borders of the Ribeira and Dom Feliciano belts respectively, are interpreted as peripheral foreland basins. The Castro, Guaratubinha, Campo Alegre, and Corupá basins are extensional and were installed on an old gneissic substrate. They are predominantly filled with bimodal volcanic material, and are here classified as continental rifts.

Except for the Castro Basin, which is the youngest of all (*ca*. 550 Ma), the available radiometric information indicates that the main magmatic phase that affected the extensional basins (*ca*. 600 Ma) preceded up to 40 Ma that of the Itajaí foreland basin (*ca*. 560 Ma), with both magmatic events taking place between the two main compressional periods of 610 and 535 Ma that can be observed in southern Brazil. Despite older, but due to their intraplate setting, the extensional basins are undeformed, whereas the Itajaí and Camarinha foreland basins clearly record deformation associated with the proximity of the adjacent belts.

Geologic Context of Itajaí Basin

The northeastern portion of southeastern Brazil encompasses five tectonic domains, juxtaposed around 600 ± 10 Ma as part of the western Gondwana assembly processes (Fig. 1). Two of the four major domains are constituted by the Paleoproterozoic gneissic-migmatitic rocks of the Curitiba and Luís Alves Microplates, which separate the Neoproterozoic Ribeira (N) and Dom Feliciano (S) belts from one another. The fifth segment occurs in the coastal region, being represented by the Neoproterozoic Costeiro Granitic Belt, constituted by a variety of granitoids and supracrustal remnants (Basei et al. 1998b).

The Ribeira Belt is predominantly composed of Mesoproterozoic metasedimentary successions deposited in a passive margin setting on the eastern edge of the Paranapanema Craton. In the Neoproterozoic, this belt behaved as an active margin, and was intensely affected by calc-alkaline magmatism represented by large granitic batholiths that constitute the roots of the Neoproterozoic Três Córregos, Cunhaporanga, and Agudos Grandes magmatic arcs. The main metamorphism and deformation overprints also occurred at this time (Basei et al. 1992, Siga et al. 2009).

The granulite-migmatitic terrains that constitute the basement of the Curitiba Microplate were grouped into the Atuba Complex (Siga et al. 1995). These are constituted by banded biotite-amphibole gneisses, amphibolites, and a variety of granitoids, which underwent medium- to high-grade metamorphism. The history of these gneisses starts with magmatism in the Mesoarchean, around 3.0 Ga (Sato et al. 2003), with a first migmatization phase in the Orosirian (~2,100 Ma) and a second migmatization phase by the end of the Ediacaran (~600 Ma). The Atuba Complex has a metasedimentary cover (Capiru and Setuva Formations) probably of Neoproterozoic age and is crosscut by several Ediacaran anorogenic granitoids.

The Santa Catarina Granulitic Complex (Hartmann et al. 1979; Kaul 1980; Basei et al. 2009) is a crustal segment consisting of high-grade metamorphic rocks, predominantly charno-enderbites and migmatitic gneisses with occasional mafic–ultramafic bodies and paragneiss remnants. The Campo Alegre Basin (~600 Ma) represents the main cover recognized in the Luis Alves Microplate central region. The north–northeast limit with the Curitiba Microplate is defined by the Piên Suture Zone (Basei et al. 1992; Machiavelli et al. 1993; Harara 2001, Harara et al. 2002).

The evolution of the Santa Catarina Granulitic Complex started with the emplacement of a 2,600 Ma TTG suite, which was later affected by regional, Siderian (2,350 Ma) granulite-facies metamorphism and by an Orosirian (2,000 Ma) granulite/amphibolite-facies metamorphic event (Basei et al. 2009). After ~1,900 Ma, the region became tectonically stable and was the only block in the southeastern Brazil that remained cold (<300°C) since the end of the Paleoproterozoic, showing no evidence of the Neoproterozoic tectono-thermal overprint that is characteristic of the other terranes in the region. Its southern border is covered with the Itajaí Basin sediments, which are in tectonic contact with the Dom Feliciano Belt supracrustal rocks, with inverse faulting responsible for tectonic imbrications related to low-angle thrusts. The domain situated farther south is represented by the Dom Feliciano Belt northern termination. As the other segments of this Belt, it is internally organized into three major compartments (Fig. 2): the *Granitoid Belt* (Florianópolis Batholith arc-related granitoids), the *Schist Belt* (Brusque Group sedimentary covers metamorphosed to the greenschist- to amphibolite-facies), and the *Foreland Belt* (Itajaí Basin supracrustal rocks).

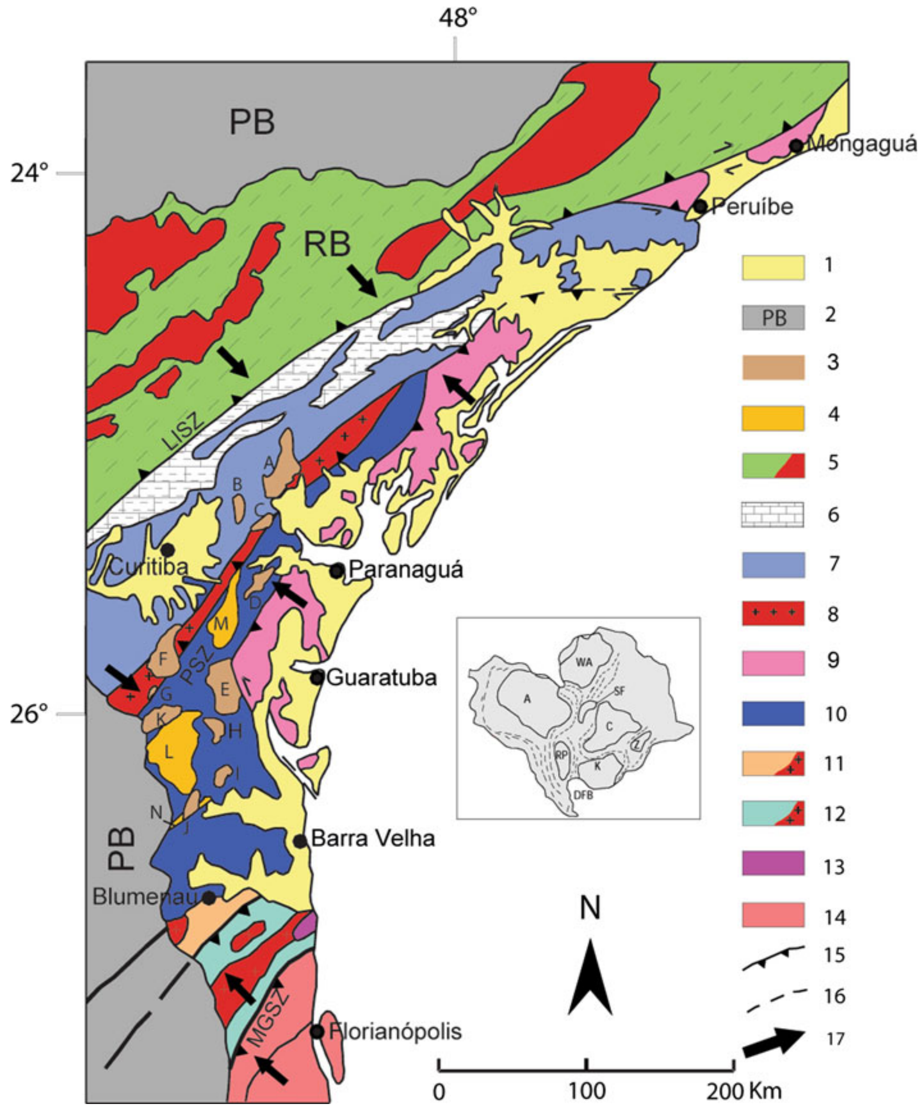

Fig. 1 Tectonic domains resulting from the amalgamation of Western Gondwana. *1* Tertiary and quaternary covers; *2* Paraná Basin; *3* Serra do Mar Suite Granites; *4* Campo Alegre Basin, *5* Ribeira Belt Southern Portion; *6* Capiru and Setuba Metasedimentary sequences; *7* Atuba Complex; *8* Rio Piên Batholith; *9* Costeiro Granitic Belt (Paranaguá and Mongaguá Batholiths); *10* Santa Catarina Granulitic Complex; *11* Itajaí Foreland Basin; *12* Brusque Group; *13* Camboriu Complex; *14* Granitoid Belt (Florianópolis Batholith); *15* thrusting; *16* inferred contact; *17* tectonic transport (Simplified after Basei et al. 2009)

The Florianópolis Batholith is predominantly composed of calc-alkaline to alkaline granitoid rocks and late isotropic alkaline granitoids. It represents the roots of an Ediacaran magmatic arc formed between 620 and 590 Ma as a result of the eastward subduction of an oceanic crust (Adamastor Ocean). The supracrustal rocks related to the Kaoko/Damara/Gariep belts represent the back–arc deposits (Basei 2000; Basei et al. 2005; 2008b). The Brusque Group stretches out in a NE–SW belt of *ca*. 40 km in width. It is composed of two metavolcano-sedimentary units separated by the Valsungana Batholith. Metavolcano-sedimentary successions predominate and represent the Brusque paleo-basin rift phase. They are characterized by tourmalinites associated with metabasalts, banded iron formations, quartzites and calc-silicate rocks, tectonically overlain by a thick metasedimentary sequence composed of micaceous quartzites, quartz-sericite schists, sericite schists, and local acid metavolcanic rocks. The granitic magmatism is characterized by three isotropic to slightly deformed granitoid suites of metaluminous to peraluminous composition marked by crustal contribution.

The Itajaí Basin

The Itajaí Basin represents a foreland-type basin of the Dom Feliciano Belt deposited by the end of the Neoproterozoic, between 600 and 560 Ma. It comprises a thick pile of sedimentary rocks with a marked turbiditic contribution and was affected by important felsic volcanic activity (Basei et al. 1998a). It is an asymmetric basin, elongated approximately in the N60E direction and having the shape of a sigmoidal prism, with thickening of sediments from north to south (Rostirolla 1991, Rostirolla et al. 1992). It occupies an area of *ca*. 700 km^2 and extends for more than 80 km from the coast of Santa Catarina to its

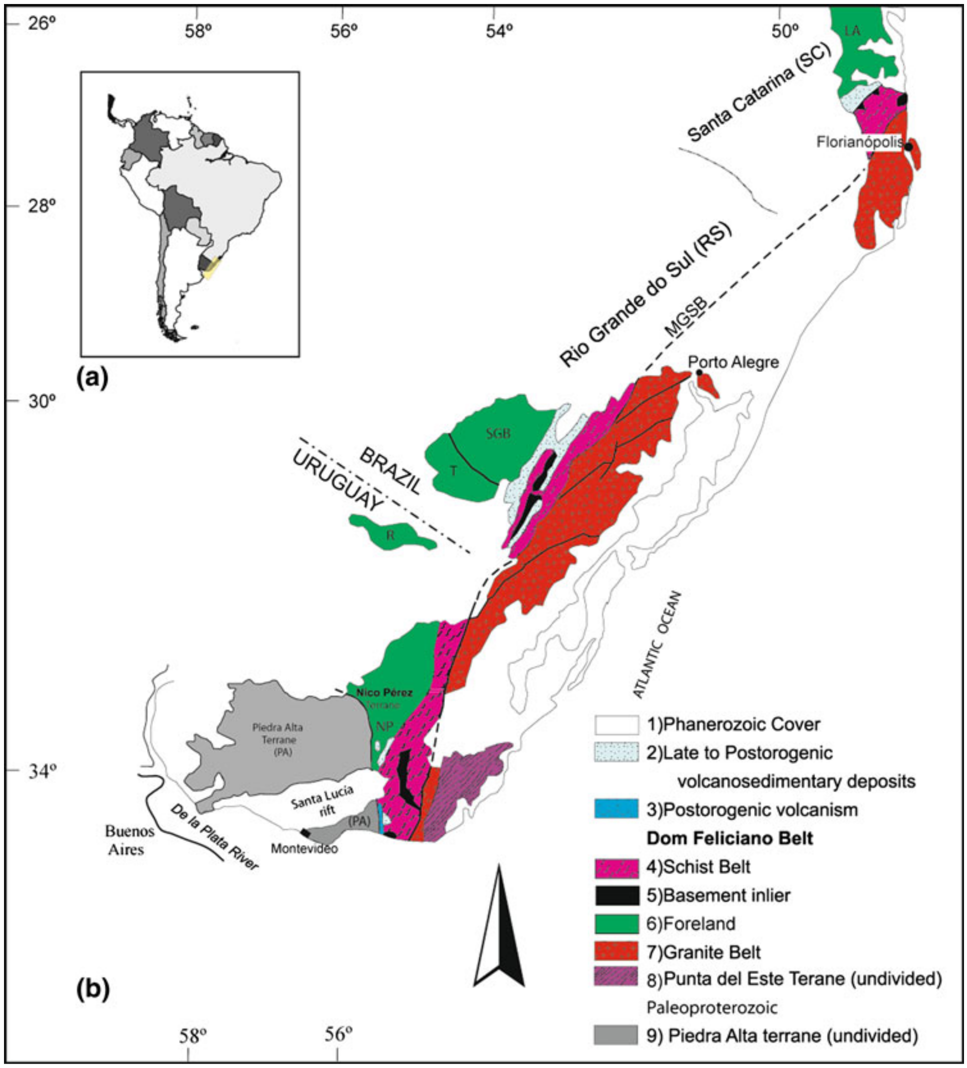

Fig. 2 Tectonic compartmentation of the Dom Feliciano Belt (modified after Basei 2000 and Basei et al. 2008a, b, c)

southeastern extremity, covered by the Paraná Basin sediments. The northern and southern limits of the Itajaí Basin are well defined in the field and distinct from one to another. The sediments of the northern border rest on Santa Catarina Granulitic Complex, the Paleoproterozoic basement of Luis Alves Microplate. In contrast, the southern border contact is predominantly tectonic, with the basal units being overthrusted by banded tonalitic-granodioritic gneisses of the São Miguel Complex and by the metavolcano-sedimentary rocks of the Brusque Group.

Studies involving the Itajaí Basin started at the begining of the 20th century with countless works focusing on stratigraphy, such as Carvalho and Pinto (1938), Freitas (1945), Maack (1947) and Salamuni et al. (1961). In this phase, the Itajaí Basin sediments were grouped into two formations and the importance of the conglomerates was recognized. In later studies (Schulz Jr et al. 1970; Kaul 1976; Silva and Dias 1981), the two formations were described in detail and correlated with basins situated to the north, the Campo Alegre Formation being defined in this period. Basei (1985) reiterated the stratigraphic division of the Itajaí Basin into two units. The lower sandy unit, equivalent to the Gaspar Formation, is composed of massive arkosic sandstones, volcanic tuffs, and thick polymictic conglomerates lenses representing proximal fluvial deposits. These are overlain by a rhythmic sandy-silty package formed by alternating silty and sandy layers and conglomeratic sandstone levels, related to proximal turbidites with channelized portions. The upper unit starts with silty-sandy deposits, interpreted as intermediate to distal turbidites. The top sediments are homogeneous, bluish, laminated argillites and siltites, related to distal, diluted turbidity currents associated with the vertical deposition. Applying sequence stratigraphy, Krebs et al. (1988; 1990); Appi (1991); Appi and Cruz (1990); Rostirolla et al. (1992, 1999) and Fonseca (2004) described the sedimentary environments in detail and proposed a series of major sequences divided into several sedimentary facies. Differing from the previous proposal, the last three works propose a third unit, which marks the return of progressively more continental depositional systems. Citroni (1993), from the recognition of depositional paleo-environments and their succession, presents a stratigraphic column represented in terms of facies associations, from base to top: Continental Associations, subdivided into interlacing fluvial sandy paleo-environments, followed by rudaceous alluvial fans; Transitional Associations, with shallow-water sandstones, deltaic sandstones, and coastal-plain sandstones; Basinal Associations, with subaqueous sliding deposits followed by hemipelagic deposits; Turbiditic Associations, with diluted turbidites; classic, medium-density turbidites; graded, dense turbidites; and sandy to conglomeratic, dense turbidites.

In the tectonic context, by means of structural framework, sedimentation pattern, regional tectonic scenario, and geochronology, several classification proposals were presented for the Itajaí Basin, which can be gathered in two main groups, one of which being the Rift-type Basin (Citroni 1993) or, in a broader sense, Molassic Foredeep, Foreland, Peripheral Foreland (Basei 2000; Basei et al. 2008b; Rostirolla 1991, Rostirolla et al. 1992, 1999; Guadagnin 2007). In the second group, the mechanism in question is flexural subsidence, related to overload of allochthonous terrains of the Dom Feliciano Belt, tectonically transported NW. Alternatively, Gresse et al. (1996), considering subduction to SW, classifies the Itajaí Basin as a foreland back-arc basin. It is here suggested, in accordance with Dickinson (1974), that the best classification for the Itajaí Basin be "peripheral foreland basin".

The Itajaí Basin lithostratigraphic units

The geologic map of Fig. 3 is a synthesis of the information collected in the Itajaí Basin over the past 20 years. The layout of the five lithostratigraphic units that constitute the Itajaí Group results from the deformation (folding and faulting) that affected the Basin. This deformation has always been neglected and consequently its great importance in the present configuration of the basin has not been appreciated. Detailed NW–SE-trending geologic-structural

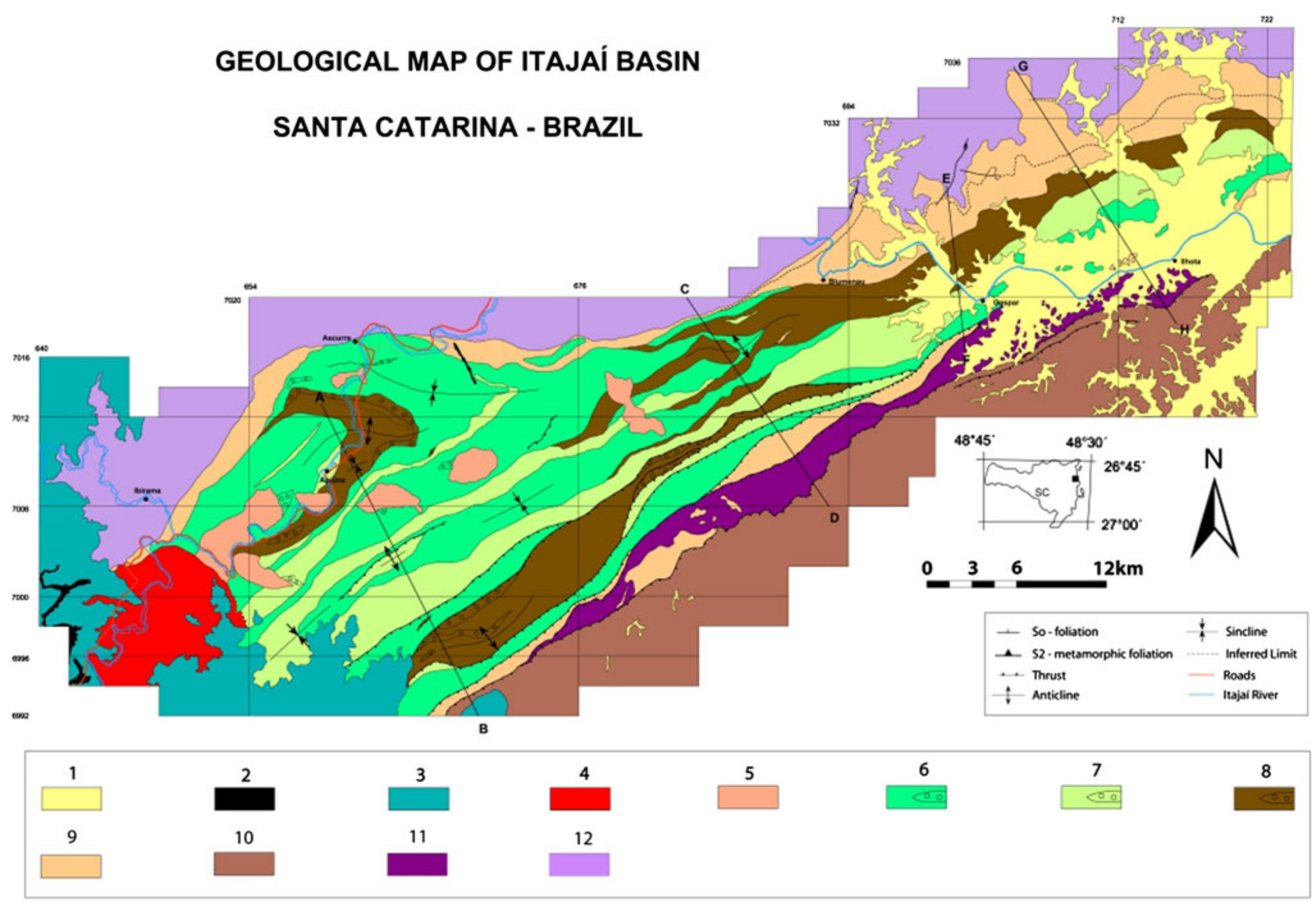

Fig. 3 Geologic map of the Itajaí Basin: *1* Quaternary; *2* Basic sill; *3* Paraná Basin; *4* Cambrian Subida granite; *5* Apiúna volcanics; *6* Ribeirão do Bode Fm; *7* Ribeirão Neisse Fm; *8* Ribeirão Carvalho Fm; *9* Baú Fm; *10* Brusque Group; *11* São Miguel Complex; *12* Santa Catarina Granulite Complex. The foliation attitudes were excluded for clarity

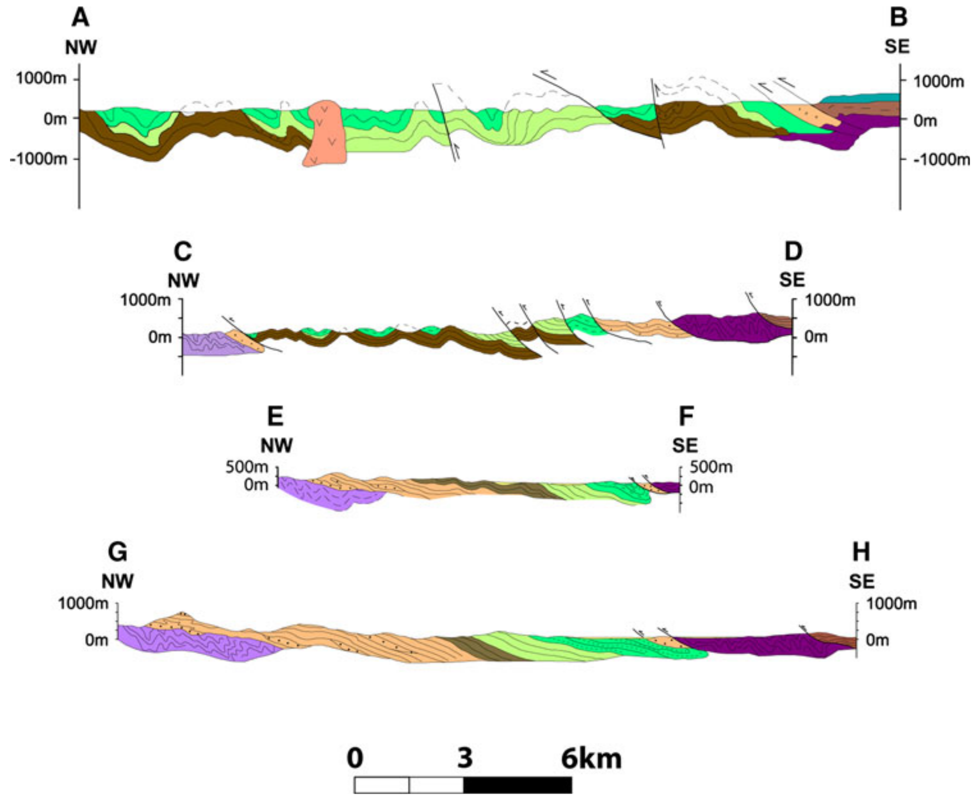

Fig. 4 Geologic-structural sections that show the spatial relationships between the mapped units. Same colors as presented in Fig. 3

sections (Fig. 4) largely contributed to the definition of the units, of the stratigraphy and to calculate the apparent thickness of each unit. To reach these aims, the surface bedding (S_0) and sedimentary features indicative of top and base were used. One of the main contributions from the geologic map was finding out that the units in the southern border represent the tectonic repetition of the basal units that are better represented in the northern border of the Basin. The proposed stratigraphic sequence must be understood as valid for the Itajaí Basin as a whole. Locally, some of the units described in the complete sequence may be lacking.

The proposed stratigraphic column (Fig. 5) was established from field relationships and the analysis of the spatial behavior of the lithostratigraphic units. From base to top, the complete sequence comprises the Baú Formation, the Ribeirão Carvalho Formation, the Ribeirão Neisse Formation, the Ribeirão do Bode Formation, and the Apiúna Formation.

The continental Baú Formation represents the basal unit and occurs in both borders. It is composed of clast-supported, polymictic conglomerate lenses that extend for hundreds of meters, having a sandy-arkosic matrix. The clasts vary from granules to boulders. They are composed predominantly of gneisses, granites, vein quartz, quartzites, and mylonites (Fig. 6a). Mica-schist clasts and fragments of rock types of the Itajaí Basin itself are volumetrically less important. Toward the top, dark red, micaceous arkosic sandstones tend to predominate (Fig. 6b). They contain sub-angular to sub-rounded grains of moderate sphericity. These rocks are poorly sorted, medium- to coarse-grained or even conglomeratic and can grade to a granule-rich conglomerate. Volcanic tuffs occur intercalated with sandy levels. The primary sedimentary structures are clast imbrication and sigmoidal cross-stratification. Nevertheless, the conglomerates are frequently chaotically organized. The sandy levels form lenticular layers with thickness varying from 0.2 to 1.2 m and show an internal massive structure or normal graded bedding, plane-parallel stratification, tabular cross-stratification, tangential cross-stratification at the base, and low-angle, small, channelized cross-stratification. The estimated thickness of this unit is 1,350 m. The deposition of this pile can be attributed to deltaic fan systems, representing immature, coarse-grained alluvial sediments that entered the basin transversally, the basal conglomeratic level representing the gravelly deltaic plain facies and the upper sandy level representing the proximal deltaic front facies (Fonseca 2004).

Overlying the Baú Formation there occur the rhythmic sediments of the Ribeirão Carvalho Formation. This 650-m-thick unit is composed of rhythmites resulting from proximal turbiditic contribution and can be divided into two main rock types: (1) Rhythmites represented by tabular bodies with rippled top and rare erosion features, composed of medium- to fine-grained sandstones intercalated with centimeter- to decimeter-sized layers of shale (Fig. 6c),

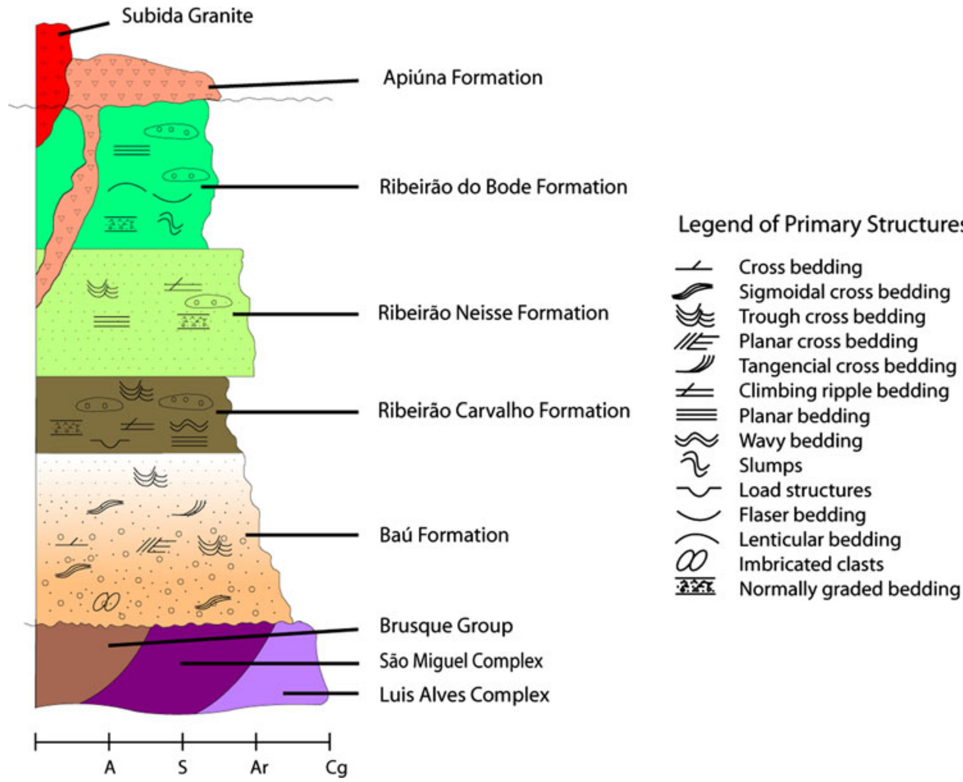

Fig. 5 Itajaí Group lithostratigraphic column, Santa Catarina

siltites, and thicker, medium-grained sandstones. They present as sedimentary structures the T_A, T_B, T_C, and T_D Bouma facies, turboglyphs, and overload structures. The best examples occur close to Apiúna, along the BR-470 highway, and are interpreted as turbiditic lobes and lobe fringes formed under a non-confined regime (Santos et al. 2008); (2) Rhythmites represented by apparently massive, slightly channelized bodies, composed predominantly of medium-sand- to coarse-sand-graded sandstones and thin sandstones intercalated with shale. These rhythmites are interpreted as channelized and lobe-channel transition turbidites (Santos et al. 2008), and are intercalated with polymictic conglomerate levels of massive structure. Locally they exhibit upward-fining and are formed by centimeter- to decimeter-sized angular to sub-angular clasts composed of quartz, milky quartz, fragments of varied Itajaí Basin rock types, and abundant acid volcanic rock clasts.

The rhythmites are overlain and in gradational contact with the 1,000 m-thick Ribeirão Neisse Formation. This formation is composed of immature, poorly sorted, fine- to medium-grained, gray arkosic sandstones, showing plane-parallel stratification, climbing-ripple cross-stratification (Fig. 6d), small- and medium-scale channelized cross-stratification, and slumps.

The upper Ribeirão do Bode Formation represents the youngest sedimentary unit of the Itajaí Group with estimated thickness of 1,500 m. It is composed of finely laminated siltites alternating with silty-argillaceous layers containing silty-sandy levels (Fig. 6e). Massive siltite levels occur subordinately. The greenish-gray laminated siltites constitute meter-sized layers with plane-parallel lamination, wavy, linsen, slump structures, and graded bedding. Intercalations of polymictic conglomerates with acid volcanics clasts occur associated with this unit.

Completing the lithostratigraphic column, rhyolitic rocks of the Apiúna Formation occur. The Subida leucosyenogranite represents the last magmatic activity to affect the Itajaí Group sediments, the emplacement taking place after the units that constitute the Basin had been deformed (Basei et al. 2008b).

Structural geology

The deformation pattern observed in the Itajaí Basin is characterized by two main folding phases with distinct axial orientations. The surface bedding S_0 is the main surface in the whole Basin. Several primary structures can be recognized, which have not been transposed by any foliation generated by the tectonic events that followed sedimentation. On the map of Fig. 7, the stereograms constructed with the attitudes of the bedding poles measured throughout the Itajaí Basin are represented. The dispersion of the foliation S_0 poles indicate that the basin was affected by two phases of cylindrical folding: the first

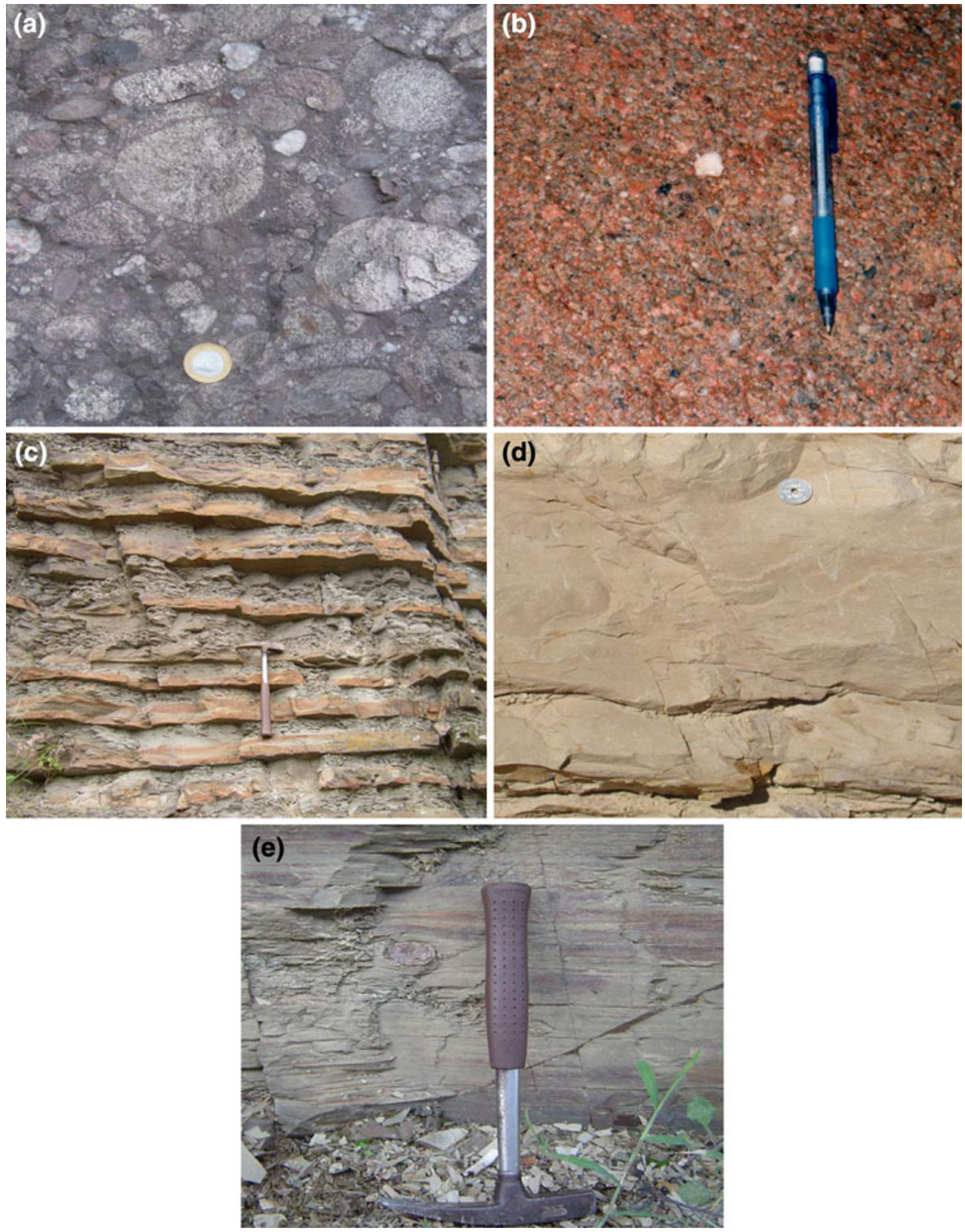

Fig. 6 **a** Clast-supported conglomerate of the Baú Formation, north of Gaspar. Imbricated clasts of gneisses, granites, vein quartz, quartzites and mylonites; **b** arkosic sandstone level in the Baú Formation; **c** proximal turbiditic rhythmites of the Ribeirão Carvalho Formation alternating medium- to fine-grained sandstones and shale and siltite layers. Ribeirão Carvalho Formation, outcrop along the BR-470 highway, between Ibirama and Apiúna; **d** poorly sorted, medium-grained, immature arkosic sandstones with medium-scale cross-stratification, Ribeirão Neisse Formation, south of Apiúna; **e** laminated silty-argillaceous sediments intercalated with decimeter- to meter-sized silty-sandy levels, Ribeirão do Bode Formation, south of Apiúna

and more intense presents preferential axial orientation between E–W and NE–SW, parallel to the length of the basin; the second strikes approximately N–S.

The first phase (D1) is the main deformation phase affecting the Itajaí Group as a whole. It is genetically associated with the thrusting that deformed the southern portion of the Basin. It is characterized by cylindrical folds, with axes parallel to the Basin elongation and to the thrusting front, which resulted from the Brusque Group overthrusting the Basin sediments, causing the repetition of the Itajaí Basin basal units in its southern flank.

Figure 8a represents phase D1 folds affecting the bedding (S_0) of the Ribeirão Neisse Formation sandstones, localized in the vicinity of Faxinal da Água Fria. Cylindrical folds (Fig. 9a) with axial orientation N70E/6° and N64E/16° are represented in this figure, the oblique cleavage poles S1 dipping much more strongly to SE, indicating tectonic vergence to NW. Figure 8b shows cylindrical folds of the same phase, which were characterized in rhythmites localized close to the Basin southern border. By using the maximum concentration of oblique cleavage S1 (Fig. 9b) data in the same section (Fig. 8c), the preferential vergence of the structures generated by D1 is confirmed to be toward NW. Phase D1 axial orientation can be clearly seen in the NW–SE sections, which are transversal to the Basin long axis. In several places, pencil structures formed by the intersection between the S1 foliation and the S_0 bedding can be found (Fig. 9c).

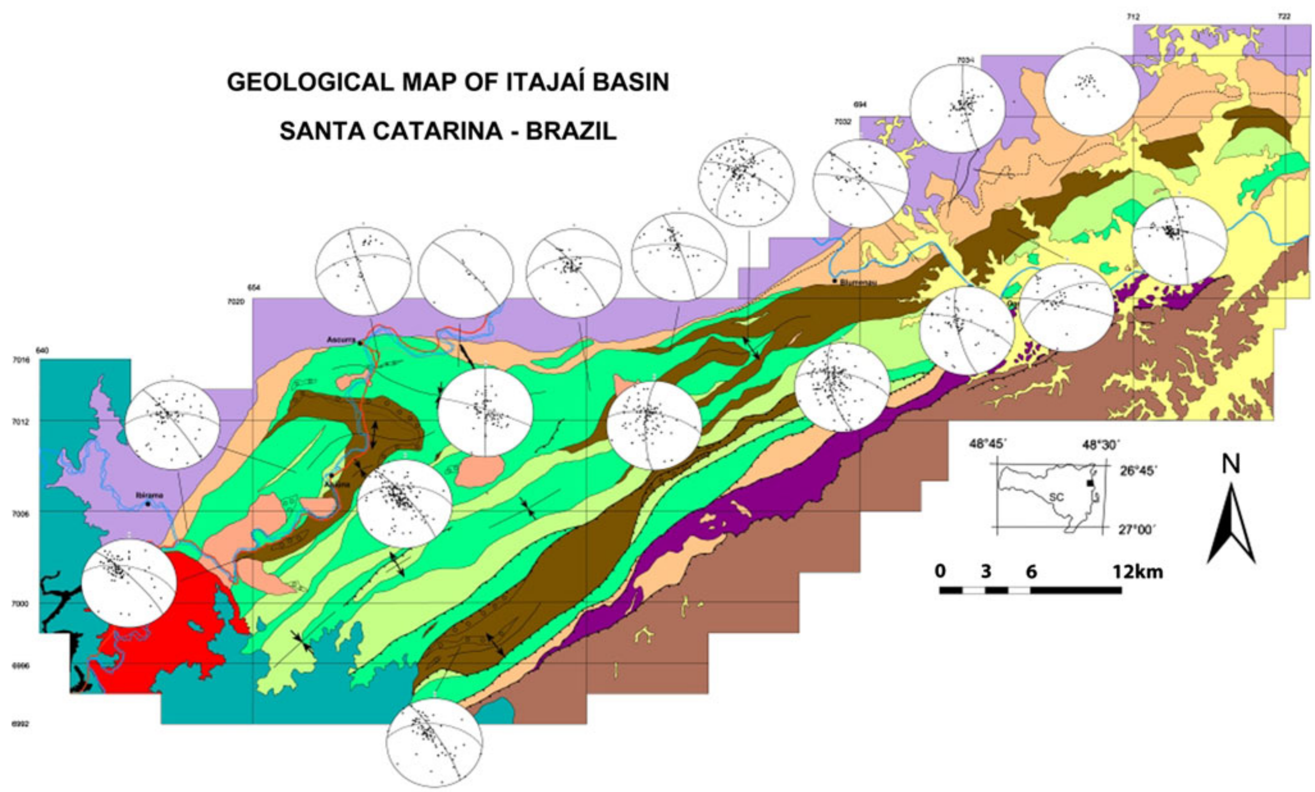

Fig. 7 Stereograms (*Schmidt diagrams*, lower hemisphere) with attitudes of the poles of the main surface S_0. Continuous girdles represent phase D1 folds; dashed girdles represent phase D2. The stereograms are drawn close to the areas where the data were collected

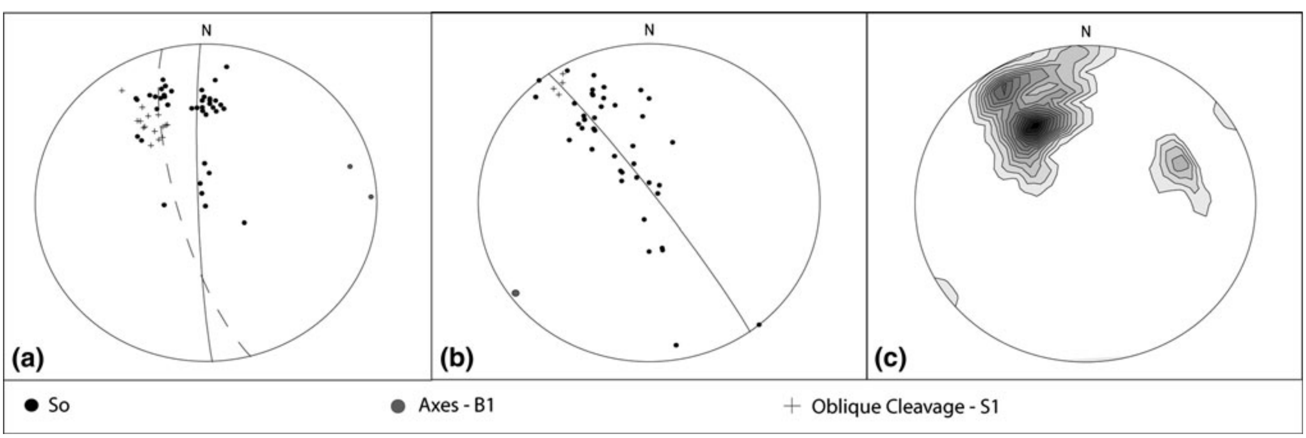

Fig. 8 D1 cylindrical folds in **a** Ribeirão Neisse Formation sandstones, and **b** Ribeirão Carvalho Formation rhythmites, representing the Itajaí Group first deformation phase—southern border, close to Faxinal da Água Fria; **c** oblique cleavage S1 along the Apiúna-Faxinal da Água Fria section (concentrations represented in descending order, from *darker* to *lighter gray*; total of 74 data; attitude of the maximum: N50E/42NW)

In the section of Fig. 10, phase D1 deformations are characterized by ample and open folds, represented by synforms and antiforms with vertical axial planes in the northern portion, which grade to inverse faults and thrusting close to the southern border of the Itajaí Basin, where the units of the São Miguel Complex and Brusque Group overthrust the Basin younger units. Section CD, located in the proximity of the Ilhota municipality, and EF, close to the Gaspar municipality (Fig. 4), shows that the changes from one sedimentary unit to another are frequently transitional. For bedding, strikes of ENE–WSW and dips of 15° to 40° SE predominate. In the northern border, the contact between the basal unit sediments and the gneisses of the Luís Alves Microplate basement (Santa Catarina

Fig. 9 Structural features—**a** Crest of phase D1, meter-sized fold, with NE-SW axial orientation. Siltites, south of Blumenau; **b** traces of S1 cleavage surface obliquous to S0 bedding in laminated siltstone; **c** pencil structures developed by S1/S0 interaction in siltstones, BR470, near Gaspar; **d** inverse faults in the contact between Itajaí conglomerates and Brusque metasediments, southern Itajaí border; **e** Sc/Ss relationship associated with fault movement parallelal to bedding plane with top displacement to NNW (*right-hand side* of the photo). Laminated siltites, Ribeirão do Bode Formation, South of Apiúna

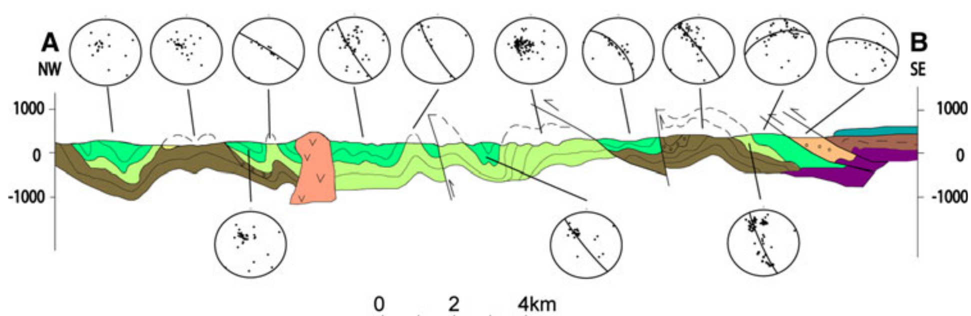

Fig. 10 Geologic section between Apiúna (*NW*) and Faxinal da Água Fria (*SE*). Stereographic projections (*Schmidt-Lambert diagrams*, lower hemisphere) of surface S_0 for each unit. The colors for each unit correspond to those of the geologic map

Granulitic Complex) is normal, whereas in the southern portion, the contact with the Brusque Group and the São Miguel Complex is tectonic by inverse faulting (Fig. 9d). Here, the basement overthrusts the Basin sedimentary units and stratigraphic inversion also occurs, as seen between Apiúna and Faxinal da Água Fria (sections a, b and c, d in Fig. 4). The amount and importance of the displacements related to the thrusts are hidden, in many cases, by shear planes parallel to the bedding surfaces (Fig. 9e).

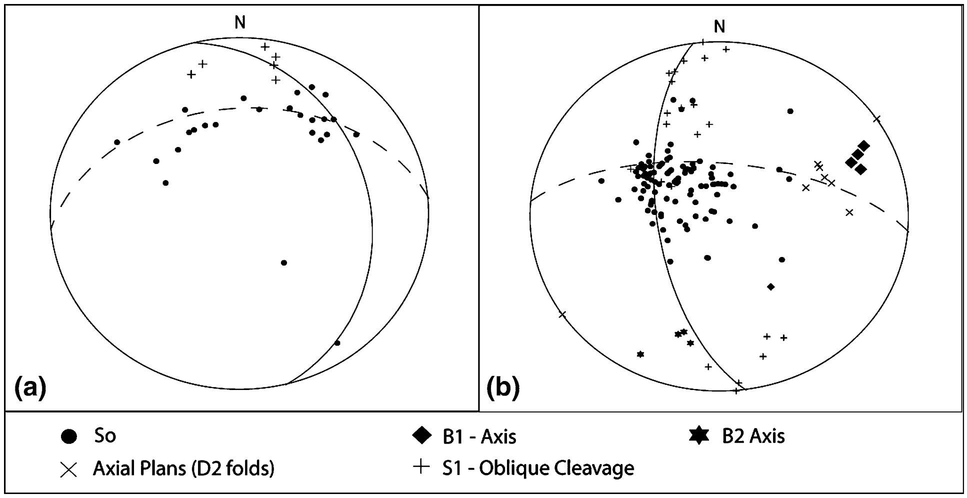

Fig. 11 Schmidt stereonet, lower hemisphere, demonstrating D2 folding and its overprint on D1. **a** Ribeirão Neisse Formation, south of Apiúna, and **b** Ribeirão do Bode Formation siltites, close to Faxinal da Água Fria

The second deformation phase D2 is represented by ample and discontinuous folds of large wavelength and approximately N–S axial orientation, in general plunging slightly southward. The stereogram of Fig. 11a, constructed with structural data for the Ribeirão Neisse Formation south of Apiúna, shows the interference of phase D2 (dashed girdle) on phase D1. This second folding of axial orientation S5 W/25° causes a dispersion both of bedding poles, represented by approximately N–S-trending layers, and the attitudes of the oblique cleavage S1 poles. The same interference pattern is seen in Fig. 11b, constructed with data from the Ribeirão do Bode Formation siltites, from near Faxinal da Água Fria. Phase D2 axis strikes S5E/50°, causing strong dispersion of bedding poles and of cleavage S1.

The comparison between the deformations recognized in the Itajaí Basin sediments and in the Brusque Group leads to the correlation of the two deformation phases in the Itajaí Basin, respectively, with the Brusque Group deformational phases D4 and D5, which affected it after the metamorphic peak (Basei 1985).

Lithogeochemistry

The geochemical study of the sedimentary rocks was carried out using 23 samples (Table 1) collected along three sections traversing the Itajaí Group units. This study aimed at understanding the variabilities between different Itajaí Basin lithostratigraphic units. The chemical composition of the terranes that acted as source areas of the Itajaí Basin sediments is probably the major controller of the geochemical signature of the Basin rocks (Rollinson 1993).

The diagram in Fig. 12a was used to classify the samples into major sandstone classes, the SiO_2/Al_2O_3 ratio serving to distinguish quartz-rich sandstones from Al-rich sandstones, and the Na_2O/K_2O ratio to distinguish wackes from arkoses (Pettijohn et al. 1972). In this diagram, the sandstones from the Baú Formation and the Ribeirão do Bode Formation are classified as arkoses, lithic sandstones and wackes, whereas the sandstones from the Ribeirão Carvalho and Ribeirão Neisse Formations are characterized as lithic sandstones. This classification is maintained in the diagram involving $Fe_2O_3 + MgO$, Na_2O and K_2O contents (Fig. 12b), except for the sandstones of the São Pedro and Ribeirão Neisse Formations, which plot in the arkose field. According to Fig. 12c, practically all samples plot on or above the $Na_2O/K_2O = 1$ line, indicating that they are quartz-rich. In Fig. 12d the SiO_2/Al_2O_3 ratio is used not only to distinguish quartz-rich sediments, wackes, and argillites but also to evaluate mineralogical maturity (Pettijohn et al. 1972). In turn, the Fe_2O_3/K_2O ratio is very useful to distinguish lithic feldspathic fragments present in sandstones. It is possible then to classify with this diagram the sediments of the Baú Formation as predominantly wackes; the sediments of the Ribeirão Carvalho and Ribeirão Neisse formations as arkoses and shale, and the sediments of the Ribeirão do Bode Formation as predominantly shale with subordinate arkoses and wackes. It was also possible to characterize all the Itajaí Basin sediments as mineralogically immature.

The "spidergrams" constructed using chondrite-normalized REE contents (McLennan and Taylor 1985) reveal a gradual increase in negative Eu anomaly and decrease in HREE fractionation from base to top. As can be seen in Fig. 13, the spidergram corresponding to the basal Baú Formation differs from those corresponding to the upper units. It shows a slight negative Eu anomaly, when compared to the intermediate values for the Ribeirão Carvalho and Ribeirão Neisse Formations and to the high values for the Ribeirão do Bode Formation. The Baú Formation shows the strongest HREE fractionation, which gradually decreases in the Ribeirão Carvalhos and Ribeirão Neisse Formations and is the weakest in the Ribeirão do Bode

Table 1 WR geochemical data (major, trace and rare-earth elements)

	IA-01	IA-02	IA-03	IA-08	IA-09A	IA-09C	IG-01	IG-02	IG-04a	IG-05B	IG-06B
SiO_2	76.2300	78.1200	72.8600	62.5100	64.1000	63.5200	69.3200	61.5600	60.9800	62.8400	63.4600
Al_2O_3	12.3200	10.7400	12.8600	17.8600	16.2600	17.2500	13.9000	17.9000	17.7900	17.7000	16.9500
MnO	0.0590	0.0830	0.0420	0.0630	0.0730	0.0630	0.0400	0.0950	0.1680	0.0900	0.1050
MgO	0.2300	0.4400	0.5200	1.5900	2.3000	2.2800	1.1600	1.8800	2.0200	1.9600	2.0400
CaO	0.0800	0.4100	0.8000	0.8900	0.3600	0.2900	1.6500	0.1100	0.0900	1.3000	0.6900
Na_2O	3.6900	2.2900	2.0500	1.4000	2.4000	2.2400	3.0900	0.9900	0.8900	2.3700	1.8500
K_2O	3.0500	3.4700	4.3700	4.8700	3.5700	4.1100	2.9800	5.0600	4.9900	4.3000	4.3000
TiO_2	0.3050	0.3240	0.5240	0.8640	0.8020	0.8180	0.4880	0.9980	0.9210	0.8420	0.7210
P_2O_5	0.0240	0.0710	0.1070	0.1570	0.1720	0.1450	0.1140	0.0360	0.0260	0.1680	0.1550
Fe_2O_3	2.4400	2.1400	2.6600	5.6700	6.5000	5.9000	3.7200	7.4200	7.7700	5.9100	6.3300
Loi	1.1800	1.4200	2.4800	3.7900	3.0300	3.1000	3.0600	3.3600	3.8400	1.9400	3.0600
Total	99.6080	99.5080	99.2730	99.6640	99.5670	99.7160	99.5220	99.4090	99.4850	99.4200	99.6610
Ba	514.4000	575.3000	586.5000	470.8000	625.7000	618.5000	993.0000	1266.4000	884.5000	800.1000	576.5000
Ce	65.0000	56.4000	89.3000	106.6000	90.5000	88.5000	81.1000	76.2000	89.8000	91.7000	92.6000
Cl	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Co	52.3000	63.0000	37.7000	25.1000	22.8000	18.8000	33.9000	25.5000	25.6000	22.0000	23.9000
Cr	26.3000	24.0000	29.3000	64.5000	76.7000	80.5000	98.6000	75.5000	95.5000	84.7000	75.3000
Cu	18.2000	8.9000	<5	30.1000	23.2000	5.4000	10.4000	<5	18.6000	23.7000	31.3000
F	<550	<550	844.8000	1362.4000	1537.7000	1459.6000	<550	967.3000	929.8000	1091.0000	1210.9000
Ga	16.2000	13.8000	17.8000	27.1000	21.7000	24.3000	17.2000	25.0000	27.9000	25.5000	24.8000
La	29.3000	35.5000	50.7000	55.8000	39.1000	37.5000	46.1000	56.1000	40.6000	54.1000	41.4000
Nb	26.3000	23.1000	25.4000	26.4000	16.8000	16.6000	17.9000	21.5000	18.6000	23.5000	21.2000
Nd	39.9000	26.7000	41.7000	56.7000	49.6000	56.8000	36.6000	58.8000	61.1000	57.8000	48.6000
Ni	9.7000	10.9000	11.4000	28.5000	36.2000	35.3000	31.6000	37.0000	40.0000	35.4000	42.4000
Pb	25.7000	29.5000	32.6000	22.6000	12.4000	4.6000	16.5000	12.1000	32.7000	18.0000	18.5000
Rb	160.9000	155.5000	204.3000	251.3000	179.4000	198.8000	70.7000	234.9000	246.7000	210.5000	215.5000
S	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300	<300
Sc	<14	<14	<14	17.8000	16.3000	15.7000	<14	17.7000	17.7000	16.8000	14.4000
Sr	85.1000	142.4000	149.1000	65.8000	75.7000	63.1000	368.1000	89.2000	50.1000	180.0000	124.8000
Th	20.8000	16.2000	25.4000	27.6000	12.7000	16.3000	15.8000	19.1000	16.4000	18.1000	12.7000
U	13.5000	12.4000	12.4000	13.7000	13.7000	15.8000	6.8000	16.1000	17.3000	11.6000	13.0000
V	25.8000	31.8000	41.0000	90.0000	103.1000	123.5000	63.1000	93.2000	83.2000	101.8000	84.6000
Y	45.6000	26.6000	38.6000	48.4000	38.0000	36.1000	17.7000	44.1000	38.2000	48.2000	37.9000
Zn	62.1000	37.7000	48.5000	99.1000	113.1000	100.0000	37.8000	86.2000	101.2000	99.4000	121.1000
Zr	184.6000	172.6000	358.9000	280.3000	214.3000	178.8000	179.0000	271.1000	221.5000	247.1000	213.4000
Sm	7.1946	5.8621	10.0652	10.1051	7.3379	6.3941	5.7650	7.0130	7.7255	8.7093	6.7026
Hf	6.7319	4.6484	10.7984	9.0700	6.5983	5.6438	5.3940	8.4414	6.9247	7.2027	6.3209

	IG-07	CTI-01	CTI-03	CTI-06	CTI-08	CTI-12A	CTI-18A	CTI-22	CTI-28	CTI-29A	CTI-37
SiO_2	71.1300	62.9800	63.7100	61.8600	72.2300	63.6200	67.3200	72.4400	62.8200	70.7300	64.9400
Al_2O_3	14.8300	17.6000	16.7600	17.3000	12.7200	17.3600	16.1600	14.1300	17.4700	13.8200	15.6500
MnO	0.0540	0.0070	0.0400	0.0600	0.0500	0.0400	0.0400	0.0400	0.0900	0.0700	0.1100
MgO	1.1800	1.6400	1.9900	1.8000	1.0700	1.6100	0.6800	0.3500	2.1600	1.3600	2.0000
CaO	0.4400	0.2100	0.3700	1.0000	1.0800	0.3400	0.1700	0.3800	0.4400	0.3300	0.8900
Na_2O	1.9000	1.6400	1.9100	1.4200	2.6200	1.9300	1.5100	3.4500	1.8600	2.7500	2.4500
K_2O	5.1700	4.6300	3.9600	4.8900	3.8000	4.6200	5.6700	3.5400	4.3500	4.2300	3.3000
TiO_2	0.2860	0.6900	0.7100	0.8400	0.5600	0.7800	0.5000	0.3300	0.8000	0.4400	0.7800
P_2O_5	0.0370	0.1100	0.1300	0.1800	0.1400	0.1500	0.0800	0.0700	0.1500	0.0900	0.1600

Table 1 continued

	IG-07	CTI-01	CTI-03	CTI-06	CTI-08	CTI-12A	CTI-18A	CTI-22	CTI-28	CTI-29A	CTI-37
Fe_2O_3	2.2800	5.3800	5.7900	6.0900	3.4100	5.4000	3.9400	2.7300	6.2800	3.5300	6.0200
Loi	2.1800	4.7000	4.4000	4.3000	2.0000	3.9000	3.7000	2.3000	3.3000	2.4000	3.4000
Total	99.4870	99.5870	99.7700	99.7400	99.6800	99.7500	99.7700	99.7600	99.7200	99.7500	99.7000
Ba	446.7000	1045.0000	558.0000	593.0000	656.0000	606.0000	741.0000	650.0000	620.0000	866.0000	610.0000
Ce	46.2000	90.2000	79.4000	92.1000	84.9000	128.5000	92.8000	84.8000	100.5000	71.6000	92.1000
Cl	<50										
Co	17.2000	49.8000	29.8000	24.3000	98.4000	27.2000	23.5000	38.4000	22.8000	59.3000	23.2000
Cr	16.5000										
Cu	8.9000	24.4000	18.0000	30.2000	119.8000	22.8000	11.0000	5.0000	22.7000	4.1000	28.1000
F	1526.5000										
Ga	23.6000	25.4000	22.1000	23.2000	17.0000	25.6000	22.9000	19.4000	23.7000	16.9000	20.4000
La	27.8000	38.6000	36.7000	40.6000	38.1000	58.3000	55.7000	36.6000	46.6000	34.0000	42.5000
Nb	29.2000	19.7000	19.4000	23.8000	25.5000	23.8000	27.0000	24.9000	20.1000	16.1000	20.2000
Nd	30.3000	38.1000	35.8000	44.8000	36.7000	55.5000	61.3000	41.9000	45.5000	26.5000	39.4000
Ni	7.2000	67.4000	33.0000	34.1000	20.1000	25.6000	12.5000	23.2000	42.8000	32.2000	35.5000
Pb	9.0000	11.4000	10.2000	17.8000	13.4000	8.5000	9.2000	13.9000	5.0000	8.6000	25.5000
Rb	299.7000	246.1000	205.9000	267.1000	176.3000	256.1000	327.3000	192.8000	206.5000	175.4000	174.3000
S	<300										
Sc	<14	16.0000	15.0000	16.0000	10.0000	15.0000	12.0000	7.0000	17.0000	8.0000	14.0000
Sr	57.4000	76.2000	73.4000	83.1000	157.2000	84.4000	87.5000	89.4000	84.1000	187.1000	164.7000
Th	33.5000	15.1000	15.8000	25.9000	18.4000	19.2000	22.9000	23.0000	19.0000	10.5000	18.6000
U	17.6000	3.5000	3.4000	5.9000	3.9000	5.1000	6.8000	5.1000	4.7000	1.5000	3.7000
V	19.4000	104.0000	96.0000	102.0000	66.0000	102.0000	58.0000	35.0000	112.0000	55.0000	91.0000
Y	52.5000	43.6000	29.3000	46.1000	24.7000	41.9000	70.9000	52.6000	36.0000	15.4000	33.8000
Zn	83.1000	130.0000	86.0000	83.0000	42.0000	86.0000	100.0000	40.0000	86.0000	45.0000	90.0000
Zr	190.4000	155.1000	164.6000	248.4000	264.3000	221.9000	195.8000	194.9000	192.2000	143.2000	245.9000
Sm	8.4271	7.1200	6.4700	9.0300	6.5600	9.7900	13.3300	9.5700	8.2700	4.0500	7.2900
Hf	7.6535	4.7000	5.0000	7.6000	7.5000	6.5000	6.3000	7.5000	6.0000	4.3000	7.1000

Formation. The lithogeochemical pattern yielded by the Baú Formation is similar to that obtained by Basei et al. (1998b) for Luís Alves Microplate basement rocks.

Provenance of the sediments inferred from the lithogeochemical data

First and foremost, the available geochemical data were treated in order to identify the possible sources of sediments for the Itajaí Basin. Even considering the limitations inherent to this approach, e.g. materials coming from tectonically distinct settings yielding geochemically similar products (McLennan et al. 1990), our study allowed the definition of several parameters to characterize source areas for the Itajaí Group sediments.

Taking into account that Th has affinity with differentiated continental crustal rocks (Faure 2005) and Sc is abundant in the mantle, Th/Sc ratios higher than 1 reveal a contribution of upper crustal rocks as source areas (Fig. 14a), favoring tectonic settings associated with continental collision, passive margins, and magmatic arcs. In Fig. 14b (SiO_2/Al_2O_3 vs. K_2O/Na_2O diagram), the preferential involvement of passive margin, continental collision, and subordinately magmatic arc settings is also indicated. In this diagram, the field related to continental collision is the one that best matches with the data corresponding to the upper sequences of the Itajaí Basin, whereas the data corresponding to the basal units are closest to the field related to the passive margin setting.

The relationship between La/Th ratios and Hf contents (Fig. 14c) indicates for all the basin units an origin related to a magmatic arc setting with important contribution of sediments associated with a passive margin setting. This suggestion is possible because, due to the low La/Th ratios yielded by the Basin sediments, which indicate Th enrichment in relation to La, a provenance from the erosion of upper crustal rocks can be suggested (Floyd and Leveridge 1987).

The comparison between present ε_{Nd} values and Th/Sc ratios (Fig. 14d) indicates that the source area for the Baú

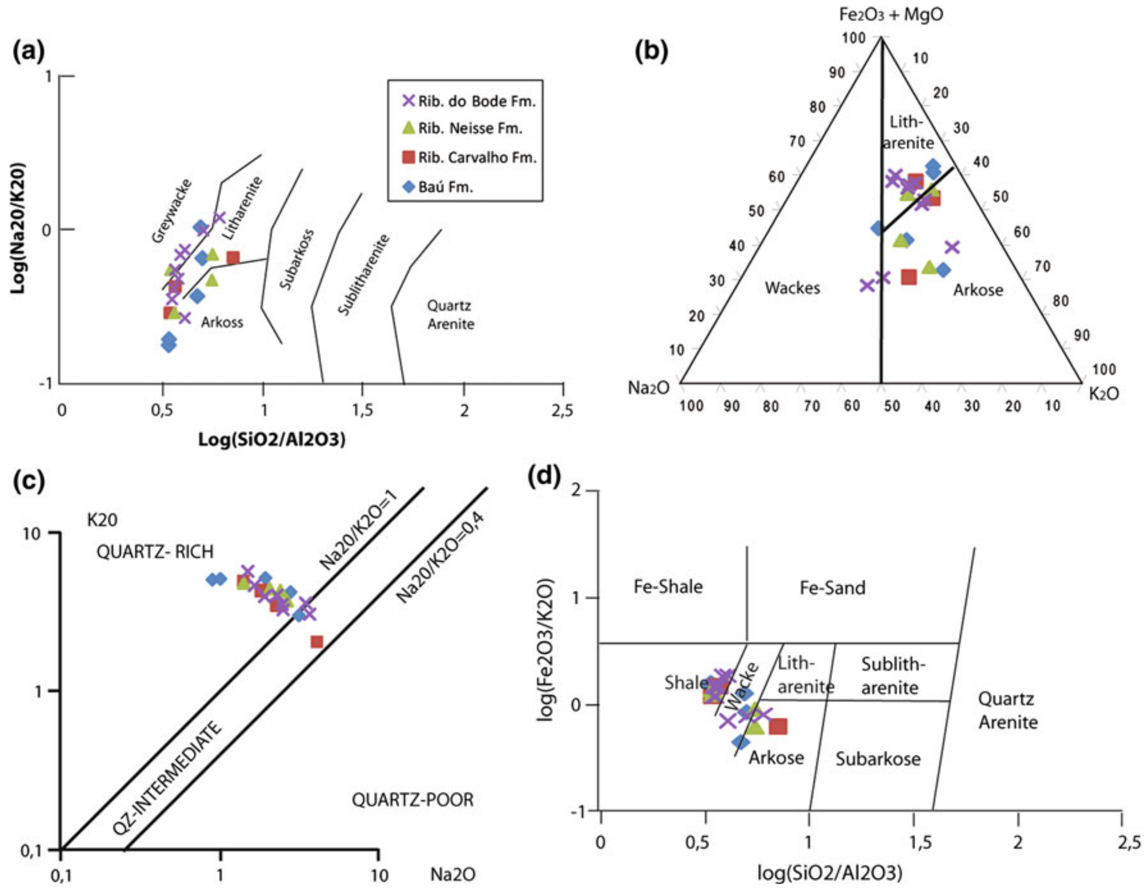

Fig. 12 Classification of sedimentary rocks according to major element contents. **a** Geochemical classification of terrigenous sandstones (Pettijohn et al. 1972); **b** Chemical classification of sandstones (Floyd and Leveridge 1987); **c** Classification according to quartz content in the sediment (Floyd and Leveridge 1987); **d** Geochemical classification of terrigenous sandstones and shale (Herron 1988)

Formation sediments (lower sequence) were rocks associated with an old crust, whereas the source area for the Ribeirão Carvalhos, Ribeirão Neisse, and Ribeirão do Bode Formations (upper sequence) were rocks associated with more juvenile, upper crustal rocks.

The geochemical studies of the Itajaí Basin sedimentary rocks helped characterize the rock types analyzed as mineralogically immature, represented by wackes, arkoses, and shale. The interpretation of REE data shows that different samples coming from the same units yielded very homogeneous results, whereas significant differences occur between samples from the continental unit and from the marine units, which attests for the reliability of the proposed lithostratigraphic column.

As indicated by the present study, the continental collision, passive margin, and magmatic arc settings can be suggested as probable settings related to the source areas for the Itajaí Basin sediments. It was equally possible to characterize the predominance of sediments coming from an old crust to the basal unit (Baú Formation) and from a younger upper crust to the upper units.

Isotopic Geochemistry

The Nd, Sr, and Pb isotopic study was carried out using the same 23 Itajaí Basin stratigraphic sequence samples as for the lithogeochemical studies. For the $^{143}Nd/^{144}Nd$ and $^{207}Pb/^{204}Pb$ data (Fig. 15), more radiogenic values correspond to the Carvalho, Ribeirão Neisse, and Ribeirão do Bode Formations, whereas less radiogenic values correspond at least to the basal portions of the Baú Formation. This fact strengthens the lithostratigraphic organization proposed and supports the suggestion that the sandstone and conglomerate units of the Itajaí Basin southern border constitute, as indicated in the geologic map, the same Baú Formation described in the northern border, therefore ruling out a third unit as suggested by Appi (1990), Appi and Cruz (1991), Rostirolla et al. (1992, 1999); Fonseca (2004) and Guadagnin (2007).

Still aiming at identifying the possible source areas for the Itajaí Basin sediments, ε_{Nd} values for samples of the Itajaí Basin and the adjacent terranes were calculated for 580 Ma, which is the mean age estimated for the Itajaí

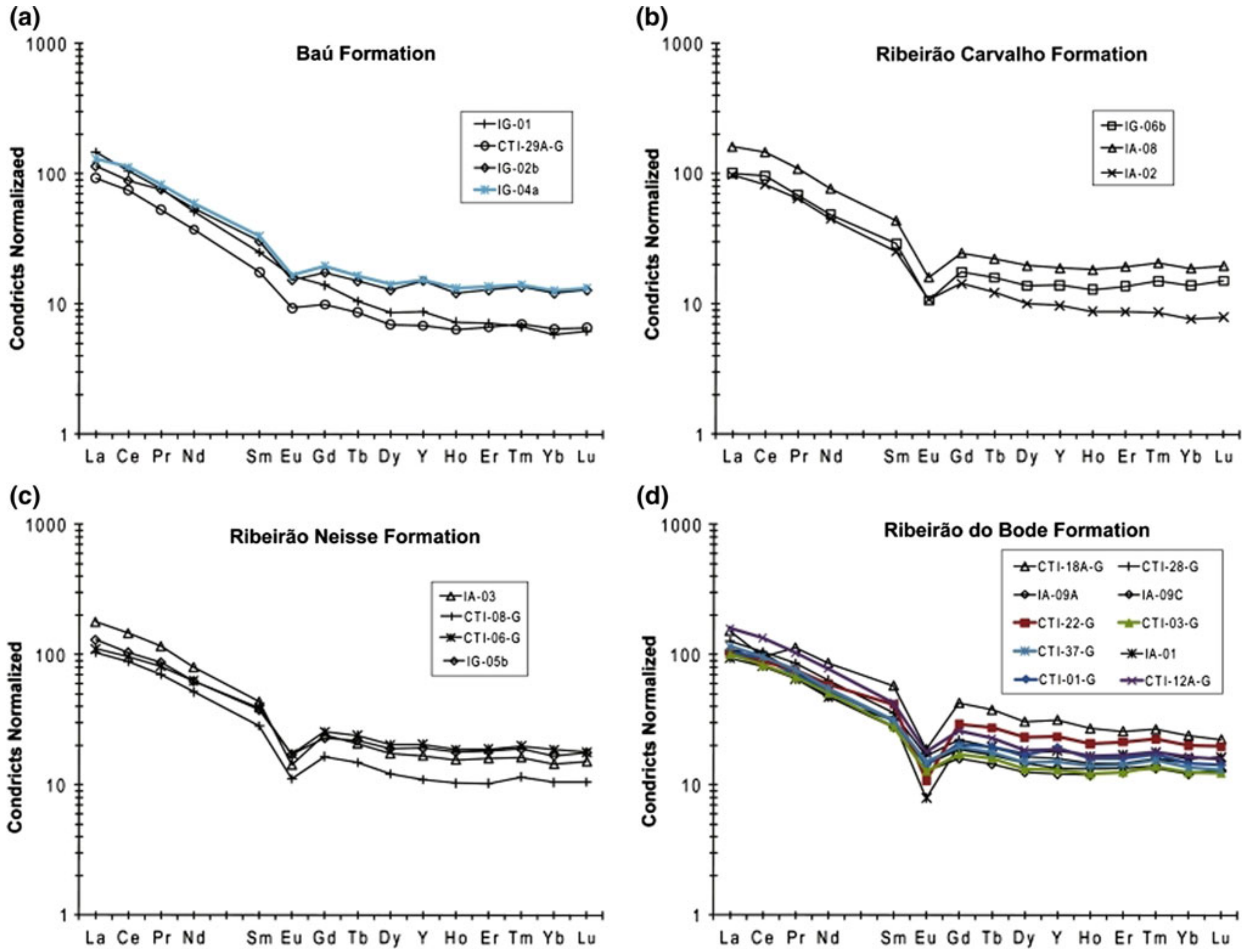

Fig. 13 Chondrite-normalized REE distribution (McLennan et al. 1995). **a** Baú, **b** Ribeirão Carvalho, **c** Ribeirão Neisse and **d** Ribeirão do Bode Formations, evidencing similar characteristics of samples from the same unit and differences between the Baú Formation and the upper units

sedimentation (Basei et al. 2008b). As seen in Fig. 16a, the calculated ε_{Nd} values for the distinct crustal segments that host the Itajaí Basin are organized according their geographic distribution along a NW–SE section. This figure shows the predominance of more negative ε_{Nd} values in the Baú Formation. These values are similar to those obtained for the Santa Catarina Granulitic Complex gneisses and indicate that the source area for the Itajaí Basin basal unit are old rocks with long crustal residence, which is in agreement with the other geochemical-isotopic information that points to these gneisses as source for these sediments. On the other hand, the values obtained for the Itajaí Basin upper units are similar to those for the Brusque Group metasediments and granites, and even to those for the Florianópolis Batholith. Comparing the ε_{Nd} (580) and ε_{Sr} (580) calculated for the Itajaí Basin sediments values, two distinct evolution trends are depicted (dashed arrows in Fig. 16b). The upper units yield approximately constant and slightly negative ε_{Nd} values and ε_{Sr} values falling in a large interval. These data plot close to the points corresponding to the Brusque Group and Florianópolis Batholith. On the other hand, it is possible to suggest a second trend defined by the Baú Formation points that indicates more negative values, closer to the points corresponding to the Luís Alves Microplate basement gneisses. Thus, it is again suggested that the possible source areas for the Baú Formation are the Santa Catarina Granulitic Complex, the Camboriú Complex, and the Brusque Group granites.

The same provenance relationships can be inferred from Fig. 16c, where the fields of Nd evolution through time (DePaolo 1988) are presented. The field defined by the Itajaí Basin completely overlaps the field defined by the Brusque Group metasediments and partially overlaps with the fields that represent the Santa Catarina Granulitic Complex, the Florianópolis Batholith, and the Brusque Group granites. The field corresponding to the Camboriú Complex model ages is very ample and almost totally overlaps the other fields.

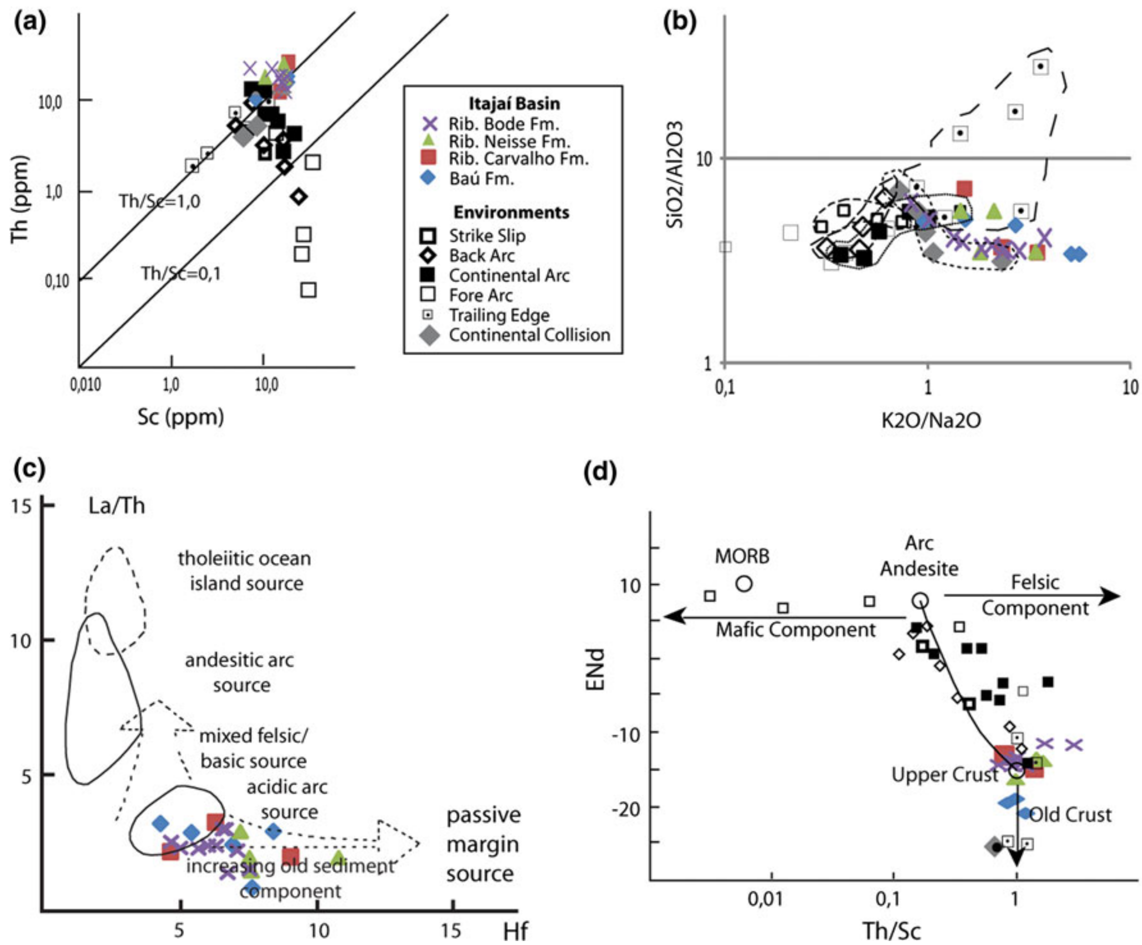

Fig. 14 Geochemical characterization of the provenance areas for the Itajaí Group sediments. **a** Th/Sc diagram (McLennan et al. 1990); **b** $SiO_2 + Al_2O_3$ vs. $K_2O + Na_2O$ diagram (McLennan et al. 1990); **c** La/Th vs. Hf diagram (Floyd and Leveridge 1987); **d** ε_{Nd} vs. Th/Sc diagram (McLennan et al. 1990)

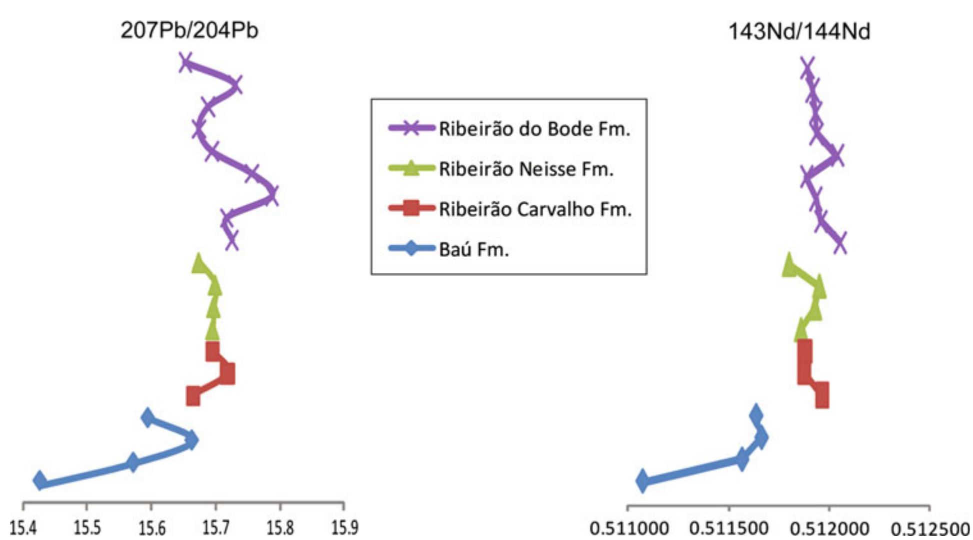

Fig. 15 $^{207}Pb/^{204}Pb$ and $^{143}Nd/^{144}Nd$ ratios *versus* stratigraphic column, characterizing similar isotopic behavior between the upper marine units and differences between these units and the lower continental unit (Baú Formation)

In conclusion, the isotopic study indicates that the rhythmites and siltites of the Itajaí basin upper sequence (Ribeirão Carvalho, Ribeirão Neisse and Bode Formations) are isotopically homogeneous and but significantly different from the lower sequence (Baú Formation) constituted by the continental sandstones and conglomerates. For the

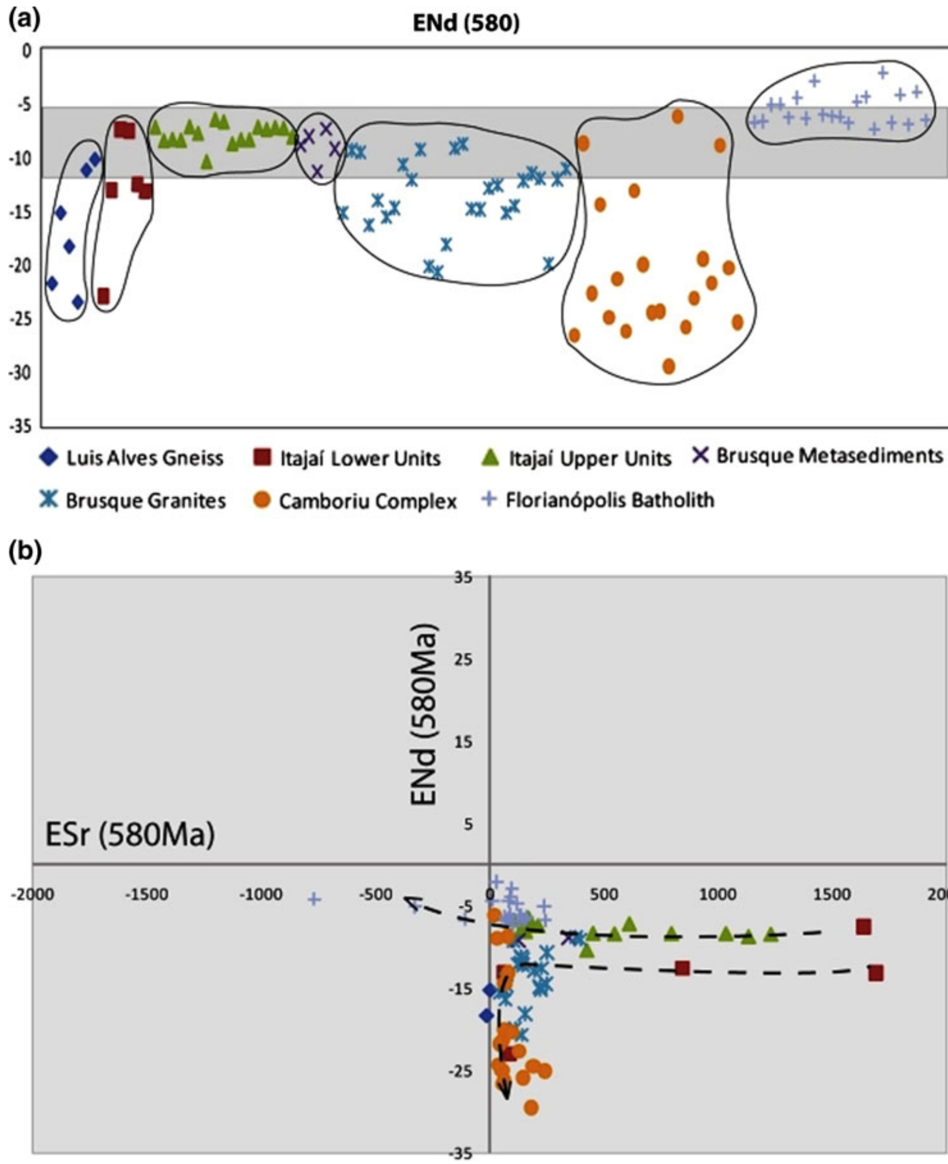

Fig. 16 Isotopic diagrams comparing ε_{Nd} values for the Itajaí Basin and the main regional geologic units (Santa Catarina Granulitic Complex, Camboriú Complex, Florianópolis Batholith, Brusque Group metasediments and intrusive granites), **a** values of $\varepsilon_{Nd(580)}$ for all regional units organized geographically according to a NW–SE section; **b** $\varepsilon_{Nd\ (580)}$ vs. $\varepsilon S_{r(580)}$ indicating distinct evolutionary trends for upper and lower Itajaí Group units

upper sequence, the $^{143}Nd/^{144}Nd$ and $^{207}Pb/^{204}Pb$ ratios are always more radiogenic and the ε_{Nd} values less negative than those yielded by the lower sequence. Model ages (Nd TDM) indicate for all the Basin units a long crustal residence, with values similar to those observed in the Brusque Group, the Florianópolis Batholith and the Camboriú Complex, and subordinately similar to those of the Santa Catarina Granulitic Complex.

The isotopic data suggest the continental sandstones and conglomerates of the Baú Formation originated by the erosion of the basement, notably the Santa Catarina Granulitic Complex, and for the source area for the rhythmites, sandstones, and siltites of the upper marine pile it was the Brusque Group metavolcano-sedimentary sequence, with contributions from the Florianópolis Batholith. This provenance is confirmed by field data. In the Baú Formation, centimeter- to meter-sized gneiss, granite, vein quartz, quartzite, and mylonite clasts, related to the Santa Catarina Granulitic Complex, and rare mica-schist fragments related to the Brusque Group are observed. In the upper units, the provenance associated with the Brusque Group is observed in thin sections, where the predominance of mica schists fragments is observed.

Geochronology

The first Itajaí Group geochronological results were presented by Macedo et al. (1984) who, on the basis of Rb–Sr isochrons of whole rock fine fractions, placed the sedimentation and diagenesis around 560 Ma. Based on Rb–Sr ages and U–Pb (TIMS) zircon analysis, Basei 1985 and Basei et al. (1999) also confined the depositional history of the Itajaí Basin to the Neoproterozoic. In disagreement

Table 2 K-Ar data of muscovite crystal

Field number	Geological unit	Rock type	Mineral	K_2O (wt%)	40 Ar* [nl/g] STP	40 Ar* (%)	Age (Ma)	2 s Error (Ma)
BR 24	Bau Fm.	Conglomerate	Muscovite	10.62	1015.53	99.47	1754.40	37.40
BR 25	Bau Fm.	Conglomerate	Muscovite	10.69	983.10	99.57	1711.00	39.00

with what was mentioned above, the identification of fossil traces and evidence of Chancelloria led Pain et al. (1997) to place the Itajaí sedimentation in the Cambrian, with the oldest possible age at 540 Ma. The deformation that affected the Itajaí Basin transformed to quartz-sericite schists by shearing the tuffaceous sediments intercalated with the basal arkosic sandstones yielded a 535 ± 11 Ma (Basei 1985). K–Ar fine fractions analysis (<2 μm) of two siltstone quarries located near Blumenau and Apiúna show 517 ± 5.0 Ma and 535 ± 11 Ma, respectively Macedo et al. (1984). These two different groups of ages suggest diachronism among the low-temperature events that characterize the thermal evolution of the Itajaí Basin.

A large detrital muscovite crystal of the Baú Formation conglomerates (BR 470 highway, in the proximity of Pedra de Amolar) were dated at Georg-August University, Gottingen, Germany, yielding ages of 1,754 ± 37 Ma and 1,711 ± 39 Ma (Table 2). These ages reinforce the suggestion given by the isotopic geochemistry, which points to the Paleoproterozoic Luís Alves Microplate gneissic basement as source for the basal continental successions. Similar conclusion was obtained by Guadagnin et al. (2010) who, on the basis of Nd and Pb isotopes, also indicated the importance of the Brusque Group as the main supplier of material for the Itajaí Basin (Guadanin et al. 2010). It is interesting to stress that this author showed (main) concentrations of ages around 600 Ma and a second group of *ca*. 800 Ma for the detrital zircons from the sandy sediments. The first group can be easily attributed to the Brusque Group granitoids, whereas the provenance for the second is still uncertain, once rocks of such age are rare, restricted to the Parapente Suite A-type magmatism (Basei et al. 2008c) of very local expression in the region.

For the zircon, SHRIMP ages presented in this paper, mineral separation was by standard gravimetric and isodynamic techniques, and the mounting of selected zircons into epoxy resin discs were carried out at the Instituto de Geociências, Universidade de São Paulo. Prior to analysis, cathodo-luminescence (CL) images were obtained to pick sites for analysis. Age determinations were performed at the Beijing Shrimp Center, China and Research School of Earth Sciences, Australia, according to standard procedures (Compston et al. 1984; Williams 1998; Stern 1998; Sircombe 2000). Data are portrayed in Tera Wasserburg diagrams generated by the program Isoplot/Ex (Ludwig 2001; Table 3). The SHRIMP method was applied to zircons from sample MBAN 1 of the same tuffaceous levels investigated by the Rb–Sr method (Fig. 18a). A weighted mean $^{206}Pb/^{238}U$ age of 596 ± 10 Ma (Fig. 17a) was obtained for the volcanogenic components and is the best estimate for the beginning of the deposition of the Itajaí Group basal portion. In two distinct localities, conglomerate levels rich in felsic volcanic clasts (Fig. 18b, c) caused much controversy regarding the stratigraphic position of this felsic magmatism. Geochronologic studies using zircons extracted from centimeter-sized fragments of felsic rock clasts (from both outcrops resulted in $^{206}Pb/^{238}U$ ages around 609 Ma (Fig. 17b, c). Considering the age errors, these results are coeval with the MBAN 1 tuffaceous sample of Bau Formation and with those observed in the Campo Alegre Basin. It represents a volcanic event, whose products were already recycled by erosion, which occurred prior to the felsic magmatism that can be recognized in the Itajaí Basin and represented by lava domes. No relationship exists between the felsic rich clast conglomerates and the late, felsic volcanism.

The best age for the Itajaí Basin felsic volcanism (Apiúna Formation) was obtained for the dome that occurs south of Apiúna (Morro do Gravatá), composed of felsic rocks (Fig. 18d) that crosscut the basin units. The $^{206}Pb/^{238}U$ age of 558 ± 6.6 Ma (Fig. 17d) represents the youngest age possible for the Itajaí Group sedimentation.

The Subida syenogranite (Fig. 18e), intrusive in the Itajaí Basin sediments, represents the youngest anorogenic granitoid recognized in the region. Its $^{206}Pb/^{238}U$ age of 520 ± 5.5 Ma (Fig. 17e) is *circa* 80–60 Ma younger than the A-type granitoids of the Serra do Mar Suite (Kaul 1984, Vlach and Gualda 2007), with which it has always been correlated.

Comparative analysis

Considering the importance of the recently published paper by Guadagnin et al. (2010) to our manuscript, a brief comparison of both works is carried out here. In a general way, both works make use of stratigraphic, isotopic, and geochronologic information on the Itajaí Basin units and present a proposal for the Itajaí Basin tectonic evolution, on the basis of their own data. Despite the tools used (LA ICPMS and SHRIMP) led to comparable results, they were applied to distinct materials: detrital zircons (Guadagnin

Table 3 U-Pb SHRIMP analytical data

Labels	Site	U (ppm)	Th (ppm)	Th/U	± Th/U	Pb* (ppm)	204 (ppb)	238U/206Pb	± 38/6
MBAN-1—Siltstone with tuffaceous contribution—Baú Formation (corrected using measured 204Pb)									
1.1	e,osc,p	285.51	263.56	0.92314	0.02286	34	2	9.83396	0.45643
2.1	e,osc,p	427.97	168.33	0.39332	0.00587	41	4	10.67875	0.52071
3.1	e,osc/hd,p	1203.27	596.74	0.49593	0.01932	113	36	11.03623	0.8314
4.1	e,osc,p	647.1	779.85	1.20515	0.01952	79	4	10.15616	0.43155
6.1	m,osc,p	304	288.41	0.94873	0.03036	33	3	10.64369	0.69462
5.1	e,osc,p	335.43	188.88	0.56309	0.01309	37	0	9.64532	0.59014
9.1	e,h,p	417.45	245.59	0.58831	0.01795	41	9	10.66171	0.70708
7.1	m,hd,p	1453.97	805.87	0.55426	0.07225	142	318	10.99862	1.87312
8.1	m,dd,p	2404.28	1700.25	0.70718	0.03159	115	945	23.08662	2.33238
10.1	e,osc,p	452.49	350.83	0.77534	0.01601	161	5	3.23886	0.17454
CT31 and CT 32—clasts of felsic volcanic—Itajaí conglomerates (corrected using measured 204Pb)									
31-1.1	m,osc,p	124.58	40.74	0.32702	0.00351	16	6	7.4654	0.18198
31-2.1	m,osc,p,fr	61.81	40.19	0.65021	0.0095	6	0	10.62627	0.36401
31-3.1	e,osc,p,fr	46.95	37.11	0.79047	0.01219	5	2	10.1916	0.31442
31-4.1	m,osc,fr	127.87	97.83	0.76507	0.00808	14	0	10.12963	0.30119
31-5.1	e,osc,p,fr	200.21	146.29	0.73068	0.00689	23	6	9.48737	0.23723
31-6.1	e,osc/h,p	158.01	203.54	1.28816	0.02637	19	5	10.38479	0.4046
31-7.1	e,osc,p	139.27	192.63	1.38316	0.01961	17	5	10.30378	0.26595
31-8.1	m,osc,p,fr	181.77	54.4	0.29927	0.00537	18	2	9.72529	0.34106
31-9.1	e,osc,p,fr	116.64	135.94	1.16549	0.01266	14	2	10.13557	0.26576
31-10.1	e,osc,p	652.68	118.86	0.18211	0.0051	66	17	9.55815	0.75126
32-1.1	m,osc,p	90.66	158.56	1.74904	0.02591	12	1	10.40936	0.3242
32-2.1	e,osc,p,fr	154.2	238.14	1.54432	0.01988	22	1	9.49905	0.32357
32-3.1	e,osc,p	525.74	380.38	0.72351	0.01496	55	2	10.60783	0.414
32-4.1	e,osc,p	34.71	95.64	2.75507	0.06982	6	1	10.25406	0.39509
32-5.1	e,osc,p	321.15	211.03	0.65711	0.00774	37	3	9.44281	0.25074
32-6.1	e,osc,p	328.45	774.78	2.3589	0.03898	51	1	9.91756	0.18395
32-7.1	e,osc,p	184.03	263.48	1.43169	0.05636	23	4	10.11287	0.47959
32-8.1	m,osc/h,p	122.32	128.01	1.04657	0.01497	13	6	10.60417	0.32207
32-9.1	e,osc,p,fr	83.21	82.44	0.99071	0.00934	9	0	10.51133	0.2621
32-10.1	e,osc,p,fr	119.99	62.26	0.51888	0.00564	13	2	10.0703	0.18618
32-12.1	e,osc,p,fr	140.63	141.95	1.00942	0.02793	16	4	10.57562	0.60027
32-15.1	m,osc,p	426.95	187.19	0.43844	0.00398	44	13	9.87361	0.24513
32-17.1	e,osc,p,fr	52.75	78.5	1.48807	0.05665	7	2	10.30806	0.53613
32-18.1	m,osc,p	196.43	139.34	0.70933	0.00856	21	1	10.18354	0.29523
32-13.1	e,osc,p	159.89	178.36	1.11549	0.01255	82	6	2.43406	0.06579
32-14.1	e,osc,p	146.21	41.77	0.2857	0.00524	30	5	4.94949	0.23435
32-11.1	m,osc,p	194.58	64.51	0.33156	0.00359	25	2	7.79364	0.21668
32-16.1	e,osc,p	316.45	160.23	0.50634	0.00341	45	1	7.42249	0.1326
Felsic volcanic—Apiúna Formation (corrected using measured 204Pb)									
API-1.1	e,h,p	40.83	29.13	0.71356	0.00871	4	0	11.03503	0.34407
API-2.1	e,h,p	47.7	49.1	1.02937	0.01716	5	0	10.90571	0.34625
API-4.1	e,h,p	83.14	92.11	1.10787	0.0134	9	0	11.00483	0.25872
API-5.1	e,h,p	54.64	34.69	0.63482	0.00933	5	0	11.03706	0.28964
API-6.1	e,h,p	59.91	63.18	1.05445	0.01317	6	1	11.33351	0.32143
API-3.1	e,h,p	34.65	34.36	0.9918	0.01666	4	2	11.2193	0.37863

Table 3 continued

Labels	Site	U (ppm)	Th (ppm)	Th/U	± Th/U	Pb* (ppm)	204 (ppb)	238U/206Pb	± 38/6
Subida Granite (corrected using measured 204Pb)									
A SUB-1.1	e,osc,p	205.44	125.59	0.6113	0.01425	19	5	11.51098	0.6656
A SUB-2.1	e,osc,p,fr	103.58	77.9	0.75212	0.02191	10	1	11.45334	0.67073
A SUB-3.1	e,osc,p	320.97	160.77	0.5009	0.01819	28	2	11.94992	0.96808
A SUB-4.1	e,osc,p	124.39	92.72	0.74543	0.01704	12	2	11.50705	0.64287
A SUB-5.1	e,osc,p	129.49	101.48	0.78368	0.01671	12	3	11.83973	0.78047
A SUB-6.1	e,osc,p	134.03	78	0.58197	0.01012	12	2	11.49571	0.52939
C SUB-7.1	e,osc,p	98.74	60.86	0.61638	0.01003	9	1	11.78418	0.60083
C SUB-8.1	e,osc,p	148.16	79.29	0.53518	0.00857	13	4	12.17256	0.66257
C SUB-9.1	e,h,p	143.7	99.08	0.68949	0.01244	13	2	12.15569	0.68554
C SUB-10.1	e,osc/hd,p	311.73	304.27	0.97607	0.00899	31	4	11.70655	0.50583
C SUB-11.1	e,hd,p	236.96	250.61	1.05758	0.0131	24	1	11.86382	0.6185
C SUB-12.1	e,hd,eq	553.05	1159.97	2.09741	0.02685	70	1	11.57709	0.56569
NC SUB-2.1	e,osc,p	182.44	151.48	0.83027	0.01486	17	18	11.95746	0.40462
NC SUB-3.1	m,osc,p	143.35	137.69	0.96055	0.01252	14	11	11.8394	0.38049
NC SUB-7.1	m,h,osc	146.48	126.41	0.86301	0.01224	14	17	11.99367	0.37179
NC SUB-1.1	e,osc,p	254.19	162.25	0.6383	0.00898	26	12	10.27715	0.28975
NC SUB-4.1	e,p,og	43.55	37.11	0.85209	0.01207	4	21	12.01428	0.54006
NC SUB-5.1	m,p,osc,h,fr	17.38	40.22	2.31356	0.05317	2	10	12.89028	0.69512
NC SUB-6.1	m,osc,p,fr	71.54	103.04	1.44038	0.02302	8	19	11.79446	0.43072
NC SUB-8.1	m,osc,p	111.72	110.32	0.98743	0.01806	10	12	12.9293	0.44761

Labels	207Pb/206Pb	± 7/6	Age 206/238	± Age	Age (207/235)	± age	Age (207/206)	± age	Conc (%)
MBAN-1—Siltstone with tuffaceous contribution—Baú Formation (corrected using measured 204Pb)									
1.1	0.05938	0.00185	624.3	27.7	615.0	27.6	580.9	69.3	107.5
2.1	0.0578	0.00123	577.1	27.0	566.1	24.4	522.1	47.3	110.5
3.1	0.05935	0.00144	559.2	40.5	563.3	36.1	580.1	53.7	96.4
4.1	0.06024	0.00127	605.4	24.6	606.8	23.0	612.3	46.2	98.9
6.1	0.05892	0.00188	578.9	36.2	575.9	34.0	564.0	70.9	102.6
5.1	0.06239	0.00118	635.9	37.2	647.4	32.2	687.6	40.8	92.5
9.1	0.05539	0.0019	577.9	36.8	548.5	33.8	428.1	78.5	135.0
7.1	0.06904	0.01105	561.0	92.2	633.1	124.1	899.8	370.8	62.3
8.1	0.05883	0.00685	273.4	27.1	305.8	44.1	561.0	276.3	48.7
10.1	0.10596	0.00089	1734.6	82.5	1733.0	47.3	1731.1	15.5	100.2
CT31 and CT 32—clasts of felsic volcanic—Itajaí conglomerates (corrected using measured 204Pb)									
31-1.1	0.06128	0.00321	810.4	18.6	768.6	33.2	649.1	116.8	124.8
31-2.1	0.06078	0.00822	579.8	19.0	590.4	66.5	631.6	321.8	91.8
31-3.1	0.05483	0.00591	603.4	17.8	563.5	51.3	405.4	261.2	148.8
31-4.1	0.05884	0.00221	606.9	17.3	597.3	23.2	561.2	84.2	108.1
31-5.1	0.05734	0.00238	646.0	15.4	615.4	23.9	504.5	94.2	128.1
31-6.1	0.0543	0.00236	592.7	22.1	551.2	26.7	383.6	100.6	154.5
31-7.1	0.05331	0.00344	597.1	14.7	546.7	31.1	341.9	153.1	174.7
31-8.1	0.05841	0.0022	630.9	21.1	612.6	25.4	545.3	84.5	115.7
31-9.1	0.05593	0.00235	606.6	15.2	574.5	23.2	449.7	96.0	134.9
31-10.1	0.06426	0.00153	641.4	48.2	666.0	42.4	750.2	51.3	85.5
32-1.1	0.05898	0.00205	591.3	17.6	586.2	22.3	566.2	77.4	104.4
32-2.1	0.06123	0.00158	645.2	21.0	645.7	21.9	647.2	56.5	99.7

Table 3 continued

Labels	207Pb/206Pb	± 7/6	Age 206/238	± Age	Age (207/235)	± age	Age (207/206)	± age	Conc (%)
32-3.1	0.06014	0.00101	580.7	21.7	586.5	20.0	608.7	36.8	95.4
32-4.1	0.05515	0.00612	599.9	22.1	563.3	54.1	418.2	269.1	143.5
32-5.1	0.06003	0.00111	648.9	16.4	639.1	16.3	604.5	40.5	107.3
32-6.1	0.06141	0.00135	619.3	11.0	626.7	14.4	653.7	47.9	94.7
32-7.1	0.05821	0.00168	607.9	27.6	593.3	26.7	537.8	64.5	113.0
32-8.1	0.05074	0.00287	580.9	16.9	514.5	27.6	229.1	136.3	253.5
32-9.1	0.06014	0.00351	585.8	14.0	590.5	30.1	608.5	131.5	96.3
32-10.1	0.05949	0.00247	610.3	10.8	605.0	21.9	584.9	92.8	104.3
32-12.1	0.05743	0.00382	582.4	31.7	567.5	41.1	508.0	153.2	114.7
32-15.1	0.05969	0.00132	621.9	14.7	615.6	16.4	592.4	48.6	105.0
32-17.1	0.0557	0.00561	596.9	29.7	565.4	52.9	440.5	241.2	135.5
32-18.1	0.05841	0.0013	603.8	16.7	591.6	17.5	545.1	49.3	110.8
32-13.1	0.13726	0.00102	2218.8	50.9	2205.4	26.4	2193.0	13.0	101.2
32-14.1	0.07592	0.00136	1186.3	51.5	1153.7	37.0	1092.9	36.2	108.5
32-11.1	0.06471	0.00101	778.2	20.4	774.8	18.3	765.0	33.1	101.7
32-16.1	0.06553	0.001	814.8	13.7	808.5	14.0	791.3	32.3	103.0
Felsic volcanic—Apiúna Formation (corrected using measured 204Pb)									
API-1.1	0.05958	0.00494	559.2	16.7	565.0	40.8	588.2	191.0	95.1
API-2.1	0.05804	0.00288	565.6	17.2	558.7	27.1	531.1	112.4	106.5
API-4.1	0.06	0.00189	560.7	12.6	569.2	18.3	603.5	69.7	92.9
API-5.1	0.05946	0.00307	559.1	14.1	564.1	26.6	584.1	116.1	95.7
API-6.1	0.05621	0.00286	545.1	14.8	529.1	25.6	460.6	117.1	118.3
API-3.1	0.04842	0.00743	550.4	17.8	474.1	63.0	119.8	326.5	459.5
Subida Granite (corrected using measured 204Pb)									
A SUB-1.1	0.05413	0.00265	537.0	29.9	507.5	32.6	376.5	114.2	142.6
A SUB-2.1	0.05792	0.00302	539.6	30.4	537.2	35.3	526.9	118.4	102.4
A SUB-3.1	0.05594	0.00157	518.1	40.5	505.7	36.1	449.9	63.5	115.2
A SUB-4.1	0.05606	0.00278	537.2	28.9	521.7	32.8	454.6	113.9	118.2
A SUB-5.1	0.05566	0.00382	522.7	33.2	507.4	41.1	439.0	160.5	119.1
A SUB-6.1	0.05566	0.00227	537.7	23.8	519.3	26.9	439.0	93.6	122.5
C SUB-7.1	0.05866	0.00223	525.1	25.8	530.6	28.2	554.4	85.0	94.7
C SUB-8.1	0.05504	0.00205	509.0	26.7	492.0	27.6	413.9	85.7	123.0
C SUB-9.1	0.0556	0.00205	509.6	27.7	496.5	28.3	436.4	84.3	116.8
C SUB-10.1	0.05587	0.00172	528.4	22.0	513.4	22.9	447.2	70.0	118.2
C SUB-11.1	0.05624	0.00102	521.7	26.2	510.7	23.3	461.9	40.5	113.0
C SUB-12.1	0.05807	0.00053	534.1	25.1	533.8	21.3	532.4	20.1	100.3
NC SUB-2.1	0.05635	0.00398	517.8	16.9	508.4	33.4	466.4	164.6	111.0
NC SUB-3.1	0.05608	0.00474	522.7	16.2	510.4	38.5	455.4	199.3	114.8
NC SUB-7.1	0.0528	0.00607	516.3	15.4	481.7	48.2	320.3	284.7	161.2
NC SUB-1.1	0.05521	0.00318	598.6	16.1	562.8	29.5	420.7	133.9	142.3
NC SUB-4.1	0.04581	0.02987	515.4	22.3	429.0	261.7	0.0	0.0	0.0
NC SUB-5.1	0.02593	0.02533	481.7	25.1	248.6	244.4	0.0	0.0	0.0
NC SUB-6.1	0.03829	0.01468	524.6	18.4	375.6	130.4	0.0	0.0	0.0
NC SUB-8.1	0.05128	0.00714	480.3	16.0	442.9	54.4	253.4	292.0	189.5

Laboratory: A = RSES (Australia); C = BSC (China); NC = new data from BSC (China)

Labels: x, y; grain number followed by analysis number

Grain habit: *p* prism, *anh* anhedral, *fr* fragment

Site: *e* end or edge, *m* middle, *int* interior, *og* overgrowth, *c* core

CL image microstructure, *osc* oscillatory finescale zoning, *rex* recrystallised, *h* homogeneous (*d* dark, *b* bright)

Data corrected with model Pb of Cumming and Richards (1975) for likely age of rock; all errors are 1 s

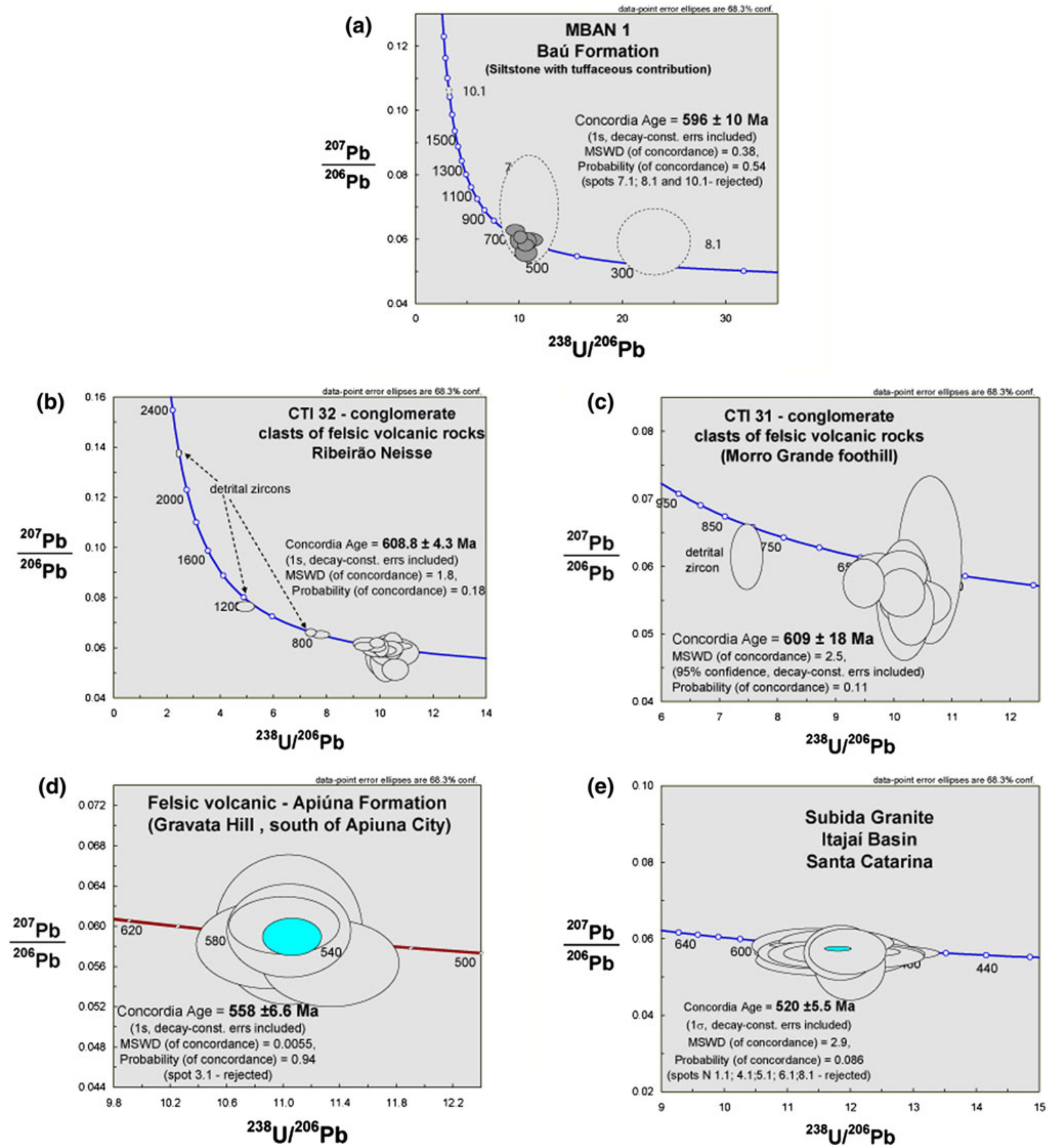

Fig. 17 **a** U–Pb diagram for the tuffaceous levels (sample MBAN 1) intercalated within Baú Formation arkosic sandstones (close to the Ribeirão do Russo, south of Blumenau). The age obtained from volcanogenic zircons constrains the oldest age limit possible for the sedimentation of the Itajaí Group lower unit; **b**, **c** U–Pb plots for zircons extracted from felsic volcanic rocks that occurs as sub-decimeter-sized (1–3 cm) in the Itajaí Group conglometares (**b** sample CT31—foot of Morro Grande, *left bank* of the Itajaí Açu river, in the proximity of Apiúna; **c** CT32 -thick conglomerate level in the upper Neisse river); **d** U–Pb diagram for the Morro do Gravatá felsic volcanic rock. The age obtained constrains the youngest age limit possible for the Itajaí Group sedimentation; **e** U–Pb diagram for the Subida leucosyenogranite. The Cambrian age obtained for this granitoid intrusive in the Itajaí Group attests for its anorogenic character and rules out any relationship with the much older Serra do Mar Suite

Fig. 18 Dated Rocks **a** Volcanic tuffs associated with sandy levels intercalated with Baú Formation conglomerates, south of Blumenau, close to Ribeirão do Russo; **b** Polymictic conglomerate with abundant felsic volcanic rock clasts; **c** Acid volcanic rock of Apiúna Formation, Morro do Gravata, south of Apiúna; **d** Pink facies of the Subida syenogranite

et al. 2010) and zircons from igneous rocks (this manuscript), which means that the former results complement the latter.

The interpretations based on (Sr, Nd, and Pb) isotopes presented in both papers are very harmonious, indicating that the Dom Feliciano Belt was the main source of material for the Itajaí Basin intermediate and upper sedimentary units. The Santa Catarina Granulitic Complex is indicated in both papers as the main candidate as source for the sandstones and conglomerates that composes the basal portion of the Itajaí Basin. Therefore, both groups of researchers agree with the classification of the Itajaí Basin as a peripheral foreland basin located between the Dom Feliciano Belt to the south and the stable and old terranes to the north.

However, some divergences appear regarding the results achieved, when specific points are compared. The ages obtained for tuffs and acid volcanic rocks, which define the limit values for the beginning and the end of the deposition of the Itajaí Group sedimentary units, are not concordant. The interval between 596 and 560 Ma presented in this work is older than the 563–549 Ma interval proposed by Gaudagnin et al. (2010).

A lower limit of 596 Ma is very close to the age of volcanism observed for the Campo Alegre Basin, which would place the deposition of both basins closer in time. This age is also closer to the well-controlled age of the basal portion of the Camaquã Basin and also is in agreement with the recently determined deposition interval for the Arroyo del Soldado Formation in Uruguay (Basei, in preparation). The older age for the beginning of the Itajaí Group deposition is compatible with the age of detrital zircons presented by Guadagnin et al. (2010), the younger populations from lower units of the Itajaí Basin indicating values around 590 M. Only for the upper unit of the base of siltites, the younger population of detrital zircons yields ages around 563 Ma, both within the interval proposed in this paper.

On the other hand, the upper limit for the deposition of the sediments is given by the age of the felsic rocks that affect the Basin sediments. The values for this magmatism were obtained in both papers by dating the Gravatá dome felsic rocks (south of Apiúna). The results were 558 and 549 Ma, the older presented in this paper. One of the possible causes for such difference can be attributed to the methods used—LA ICPMS by Guadagnin et al. (2010) and SHRIMP (our work).

Other divergent points reside in the implications that result from the different stratigraphic columns presented in both works. In our paper, sandstones, conglomerates, and acid tuffs that occur on the southern border of the Itajaí Basin are interpreted as a tectonic recurrence of the Bau Formation (lower unit), whereas in Guadagnin et al. (2010) these rocks integrate the upper unit, which would indicate the return of continental conditions that predominated in the beginning of the Itajaí Basin evolution. Our stratigraphy reflects the reading of the geological map presented in this paper, where the modifications introduced by the epidermal tectonics, which deforms the basin, characterizes it as a typical example of a thrust and fold belt, and explains the occurrence of the same rocks on both borders. The major deformation of the southern border units, the similarities observed in the sedimentary associations of both borders, a compatible isotopic signature (Nd and Pb) and comparable provenance ages, led us to consider that a more correct interpretation is that the rocks from both borders compose a single lithostratigraphic unit.

Another point in favor of a proposal that involves the repetition of the lower unit in the southern border is the pattern yielded by detrital zircons presented by Guadagnin et al. (2010), which shows that the provenance of the zircons from sandstones and conglomerates attributed by these authors to the upper units is similar to the pattern presented by the lower units that occur on the northern border (Bau Formation) and quite different from the ages observed at the base of the siltite unit, which for us represents the true top of the Itajaí Basin, that yields detrital zircon ages restricted to Neoproterozoic values.

Conclusions

The integrated approach, involving information coming from cartography, lithostratigraphy, structural geology, lithogeochemistry, isotopic geochemistry, and geochronology, helped reinforce a new and more detailed interpretation for the Itajaí Basin tectonic evolution.

The proposed lithostratigraphic column assigns the Itajaí Group rocks into two major sequences: a basal continental and an upper marine sequence. The lower sequence (the Baú Formation) is represented by sandstones and conglomerates deposited in alluvial and retrograding deltaic fan systems, with facies varying from gravelly and sandy deltaic plain, grading to proximal and distal deltaic front, to prodelta. This sequence grades laterally and toward the top to the upper sequence, constituted by the Ribeirão Carvalho Formation rhythmites, which represent the proximal channelized and non-channelized turbiditic facies, the Ribeirão Neisse Formation arkosic sandstones, and laminated siltites of the Ribeirão do Bode Formation distal turbiditic facies.

Based on the similarities between the sandstones and conglomerates that occur in both borders of the Itajaí Basin, it is emphasized that these rock types belong to the Baú Formation. Besides the similar geochemical-isotopic characteristics, the continuity of these rocks can be checked in the geologic map, which shows the Pedra de Amolar region as the junction between the units of both borders. The proposal that the sandstones with continental characteristics that occur in the southern border represent a third unit is thus ruled out. They in fact represent tectonic repetitions of the basal unit by inverse faulting.

The structural studies indicate that the intensity of phase D1 was highest in the SE portion of the Itajaí Basin, close to the orogenic belt, with NE–SW axial orientation characterized by folds with vertical axial planes close to the northern border, grading to megafolds of inverse flanks, inverse faults and thrusting in the southern portion, with clear tectonic vergence to NW, toward the foreland. Thrusting with a NW direction of transport and preferentially affecting the southern border of the Basin is associated with this phase. Phase D2 is restricted to discontinuous folds of large wavelength and approximately N–S axial orientation and slight southwards plunge. The interference of phase D2 on phase D1 is observed at various scales, in the outcrops and in the regional map. These phases are directly related to the deformational phases that followed the metamorphic climax in the Brusque Group.

The study of the susceptibility anisotropy and remanent magnetization in two sites of the Gravata rhyolitic dome has shown that these igneous rocks were affected only by the Itajaí Basin second deformational phase, which places the first phase between 600 and 560 Ma and the second phase syn- to post-560 Ma. Additionally, this chronology of events indicates, in agreement with the information obtained by magnetostratigraphy, a short period between deposition and deformation phase D1, implying possible syn-tectonic sedimentation (Drukas 2009).

The lithogeochemical (major, trace and rare earth elements) and isotopic (Sr, Nd and Pb) analyses of the sedimentary rocks gives support to the proposed lithostratigraphic column. A very homogeneous behavior is observed in the units that compose the upper sequence, which is at the same time significantly different from that of the lower sequence. Among the various tectonic settings possible, it is proposed that the precursors of the Itajaí Group sediments were generated in settings geochemically associated with continental collision, passive margins and magmatic arcs. The probable candidates to source areas of the upper sequence sediments, with marked contribution from the upper crust, are the Brusque Group and the Florianópolis Batholith. The proposed candidates for the continental and lower units, whose geochemical signature shows considerable contribution from reworked old crust, are the terranes of the Luis Alves, São Miguel, and Camboriú Complexes.

The Itajaí Basin is thus interpreted as a peripheral foreland basin directly related to the evolution of the Dom Feliciano Belt. The late-collisional shortening of the fold belt, represented by the Brusque Group, led to the formation of the Itajaí Basin by flexural subsidence. The deposition of the basal continental sequence started with the erosion of its basement, notably the Santa Catarina Granulitic Complex, with some contribution from the Dom Feliciano Belt. With the increasing proximity of the adjacent Brusque Group orogenic belt and the Florianópolis Batholith (magmatic arc), these became the main sources for the sediments of the upper, turbiditic marine sequences. The Itajaí Basin and the Brusque Group would then be situated in the lower plate of this passive margin context (Luís Alves Microplate southern border), whereas the Florianópolis Batholith, representing the roots of a Neoproterozoic magmatic arc, south of the Major Gercino Suture Zone, would be situated in the upper plate in the active margin setting. The generation of the Itajaí Basin occurred in a late-collisional setting that followed the termination of the subduction of oceanic crust southeastwards, around 600 Ma.

The lack of records indicating a rift-type opening leading to the development of an oceanic crust implies that the Itajaí Basin upper marine units were deposited in an environment similar to a restricted and internal sea. The geologic history of the Itajaí Basin must have started around 600 Ma, with the deposition of the lower units on the gneisses of the Luís Alves Microplate southern border. Around 560 Ma, the sedimentation ceased, as attested by the Apiúna Formation felsic magmatism, expressed as dikes and domes crosscutting the whole sedimentary succession. The emplacement of the felsic volcanism after the first deformation phase (Drukas 2009) implies a maximum time interval of 40 Ma for the deposition and the first deformation phase. In the Cambrian, close to 520 Ma, after the stabilization of the Itajaí Basin, the intrusion of the anorogenic Subida leucosyenogranite took place.

Based on the available radiometric data, it is demonstrated that the deposition of the Itajaí Basin was exclusively restricted to the Neoproterozoic. Respecting the differences inherent to the details acquired during their evolutions, the Itajaí Basin can be temporally and tectonically correlated with the Camaquã Basin in Rio Grande do Sul (Pain et al. 1990, Fragoso Cesar 1991) and the Arroyo del Soldado/Piriápolis Basin in Uruguay (Gaucher and Sprechmann 1998, Gaucher et al. 1996, 2009). It also presents several tectonic-sedimentary characteristics in common with the Nama Basin, its equivalent in Africa (Gresse et al. 1996, Frimmel and Miller 2009, Germs et al. 2009; Guadanin et al. 2010).

Acknowledgments The authors are grateful to many colleagues of the Institute of Geosciences—USP for the fruitful discussions. Most of field and laboratory work were supported by grants from the São Paulo State Foundation of Research Support (FAPESP—2005/58688-1).

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