

Annual Report* of IGCP Project No.478

*The information in this report will also be used for publication in 'Geological Correlation' (please feel free to attach any additional information you may consider relevant to the assessment of your project).

IGCP project short title: **“Neoproterozoic-Early Palaeozoic Events in southwestern Gondwana”**

Duration and status:

2003-2007, active

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Project Secretary: N/A

Date of submission of report (UNESCO Office Montevideo): 10th November 2005

Signature of project leader:

Dr. Claudio Gaucher

1. Website address(es) related to the project

Official website: <http://www.vssagi.com/igcp478/igcp478.htm>

Mirror website: <http://www.igcp478.com>

Related website: <http://www.congresos-rohr.com/vssagi/ingles/home.htm>

2. Summary of major past achievements of the project

2.1. Scientific achievements 2003-2005

Chemostratigraphy. A considerable amount of C, O and Sr chemostratigraphic data has been obtained for a number of Neoproterozoic to Ordovician carbonate successions in SWG by the IGCP 478 working group, namely (Fig. 1):

- Araras Group of western Brazil (Alvarenga et al., 2004),
- Corumbá Group (Boggiani et al., 2003; Gaucher et al., 2003a),
- Paranoá and Bambuí Groups of Brazil (Alvarenga et al., 2003a, b),
- Seridó Group of NE Brazil (Nascimento et al., 2004),
- Arroyo del Soldado Group (Gaucher et al., 2003b; Gaucher et al. 2004a, b),
- Port Nolloth Group of southern Namibia (Frimmel, 2004; Frimmel & Fölling, 2004)
- Sierras Bayas Group of Tandilia, Argentina (Gómez Peral et al., 2004)
- La Laja, Zonda, La Flecha and La Silla Formations from the Argentine Precordillera (Sial et al., 2003; 2004), recording the global Steptoean anomaly
- Caucete Group of western Argentina (Cingolani et al., 2003).

In 2005, detailed carbon and strontium isotope curves were obtained for six group-rank units in SWG, ranging in age from early Neoproterozoic to Cambrian. These are:

-The Mina Verdún Group of Uruguay, characterized by negative $\delta^{13}\text{C}$ values of up to -3.3 ‰ PDB at the base (La Toma Formation), rising to a plateau around $+2$ ‰ PDB (maximum: $+4.0$ ‰ PDB; Gaucher et al., 2005c). These values suggest a late Mesoproterozoic to early Neoproterozoic (Tonian) age for the unit (Kah et al., 1999). U-Pb dating of interbedded volcanic rocks and Sr isotope chemostratigraphy will help constrain the age of the Mina Verdún Group.

-New Sr and C isotopic data were presented by Alvarenga et al. (2005) for the Paranoá and Bambuí Groups (Sao Francisco Craton, Brazil, Fig. 1). Carbonates of the Paranoá Group are characterized by positive $\delta^{13}\text{C}$ values ranging between $+0.8$ and $+2.6$ ‰ PDB, and low $^{87}\text{Sr}/^{86}\text{Sr}$ values between 0.7056 and 0.7068. On the other hand, the Bambuí Group records high-amplitude $\delta^{13}\text{C}$ excursions between -5.9 and $+9.2$ ‰ PDB, and $^{87}\text{Sr}/^{86}\text{Sr}$ ratios (Sete Lagoas Formation) between 0.7074 and 0.7080.

-Tosselli et al. (2005) presented the first C, O and Sr isotopic data for carbonates occurring in the Puncoviscana Formation (NW Argentina).

-Sial et al. (2005) reported detailed C, O and Sr isotopic data for the Estância-Miaba Group and the Vaza Barris Group (Sergipano Belt, Brazil). Values of $\delta^{13}\text{C}$ around -2 to -8 ‰ PDB are observed in both cap carbonates (Acauã/Jacoca and Olho D'Água Formations) overlying the possibly glaciogenic diamictites of the Ribeirópolis and Palestina Formations. $\delta^{13}\text{C}$ values for carbonates between diamictites vary from $+3$ to $+8$ ‰ PDB. Carbonates on top of the younger diamictite (Palestina Formation) yielded heavy $\delta^{13}\text{C}$ values of $+8$ ‰ PDB, with some values as high as $+10$ ‰ PDB. Lowest $^{87}\text{Sr}/^{86}\text{Sr}$ values obtained for the succession range between 0.7072 and 0.7083.

-The Caucete Group (Pie de Palo Range, Argentina) yielded $\delta^{13}\text{C}$ values consistently around 0 (-1.2 to $+0.3$ ‰ PDB), and near-primary $^{87}\text{Sr}/^{86}\text{Sr}$ values between 0.7089 and 0.7095, suggesting a Lower Cambrian age (Naipauer et al., 2005).

Palaeontology. A number of new occurrences of fossils in Neoproterozoic successions in SWG has been reported in 2003-2004 within the framework of IGCP 478. These include:

-Organic-walled microfossils (acritarchs, cyanobacteria) from the Corumbá Group (Gaucher et al., 2003a), Las Ventanas Formation of Uruguay (Blanco & Gaucher, 2004), Pouso Alegre, Pico de Itapeva and Eleutério basins of SE-Brazil (Teixeira & Gaucher, 2004), Cango Caves and Gamtoos Groups of South Africa (Gaucher & Germs, 2003; Germs & Gaucher, 2004), and the Arroyo del Soldado Group (Gaucher et al., 2004c),

-*Eoholynia*, a vendotaenid algae, from the Corumbá Group (Gaucher et al., 2003a).

-*Otavia*, possibly the oldest sponges so far reported, from the Ombaatjie and Auros Formations of the Otavi Group, northern Namibia (Brain et al., 2003),

-*Cloudina* Germs (1972) from the Itapucumí Group of Paraguay (Boggiani & Gaucher, 2004) and possibly the Eleutério Basin (Teixeira & Gaucher, 2004),

-*Titanotheca coimbrae* Gaucher & Sprechmann (1999) from the Corumbá Group (Gaucher et al., 2003a), Pico de Itapeva and Cajamar basins (Teixeira & Gaucher,

2004; Hachiro et al., 2004), Holgat Formation (Gaucher et al., 2005a), and with doubts from the Cango Caves Group (Gaucher & Germs, 2003),
 -Stromatolites from the Mina Verdún Group (Poiré et al., 2003) and Cerro Victoria Formation (Sprechmann et al., 2004) of Uruguay
 -Diverse trace fossils and wrinkle structures from the Puncoviscana Formation (Aceñolaza & Aceñolaza, 2003; Buatois & Mángano, 2003a, b), and *Thalassinoides* (indicating a maximum Cambrian age) for the Cerro Victoria Formation (Spechmann et al., 2004).

A biostratigraphic correlation at formational level of the Cango Caves and Gamtoos Groups of the Saldania Belt (Fig. 1) has been proposed by Gaucher & Germs (2005), on the basis of acritarch biostratigraphy. The authors recognize three different acritarch assemblages: a basal, *Bavlinella faveolata*-dominated assemblage, followed by a *Soldadophycus*-dominated assemblage and a *Leiosphaeridia*-dominated microflora at the top. The Sardinia Formation hosts a *Comasphaeridium* assemblage suggesting a Lower Cambrian age for this unit.

Gaucher et al. (2005a) report a low-diversity assemblage of organic-walled microfossils from the Holgat Formation, Gariep Belt (Fig. 1). They occur within and immediately above cap carbonates deposited on top of the Numees tillite. Only poorly-preserved *Bavlinella faveolata* specimens occur beneath the Numees Formation, in organic-rich marls and shales of the Pickelhaube and Wallekraal Formations. Acritarchs support previous Pb-Pb dating and chemostratigraphy of post-Numees cap carbonates, indicating an age as young as 555 Ma.

Gaucher et al. (2005b) report the occurrence of *Cloudina* and acritarch assemblages dominated by *Leiosphaeridia* from the Sierras Bayas Group and Cerro Negro Formation of Tandilia, Argentina (Fig. 1). The fossil assemblages allow to assign the Cerro Largo, Loma Negra and lower Cerro Negro Formations to the late Ediacaran. A correlation with the Arroyo del Soldado and Corumbá Groups of Uruguay and Brazil is envisaged by Gaucher et al. (2005b) in view of the new data. It is worth noting that the fossils described by the authors are the oldest so far reported from Argentina.

Blanco & Gaucher (2005) report acritarchs from Las Ventanas Formation of Uruguay. The assemblage is dominated by large *Leiosphaeridia*, and pre-dates the Arroyo del Soldado Group. The authors assign the microflora to the Simple Leiosphere Palynoflora of Grey et al. (2003), which postdates the Marinoan Glaciation but predates the Ediacaran Complex Acanthomorph Palynoflora.

Bona fide Ediacaran fossils are so far absent from South America. Aceñolaza et al. (2005) describe possible *Nemiana* or *Beltanelloides* and *Selkirkia* sp. from the Puncoviscana Formation of NW-Argentina (Fig. 1), with the potential of becoming the first Ediacaran fossils described from South America.

Correlation. Correlation of late Neoproterozoic sedimentary successions was improved during 2003-2005, mainly due to advances in chemo- and biostratigraphy described above. The Corumbá and Arroyo del Soldado Groups (Brazil and Uruguay, Fig. 1) were correlated by Gaucher et al. (2003a), on the basis of litho-, bio- and chemostratigraphy. The Sierras Bayas Group yielded similar acritarch assemblages and comparable C and Sr isotopic values, leading to a correlation at the

formation level with the Arroyo del Soldado and Corumbá groups (Gaucher et al., 2005b).

Acritarch biostratigraphy enabled correlation of the Cango Caves Group (South Africa) with both the Nama Group (Namibia) and the Arroyo del Soldado Group (Gaucher & Germs, 2003). Biostratigraphic data (acritarchs, skeletal fossils) also support correlation of the Eleutério, Pouso Alegre, Pico de Itapeva and Cajamar basins of southeastern Brazil with the Arroyo del Soldado Group (Teixeira & Gaucher, 2004). Correlation of the Araras and Corumbá Groups has been re-examined, the latter being probably slightly younger in age (Boggiani & Alvarenga, 2004).

Tectonic events. Significant advances have been made in unravelling Cambrian tectonic events in the Ribeira Belt, indicating that Gondwana amalgamation was not finished until the latest Cambrian-Early Ordovician (Schmitt et al., 2004; Heilbron & Machado, 2003; Heilbron et al., 2004). Likewise, Bossi & Gaucher (2004) proposed

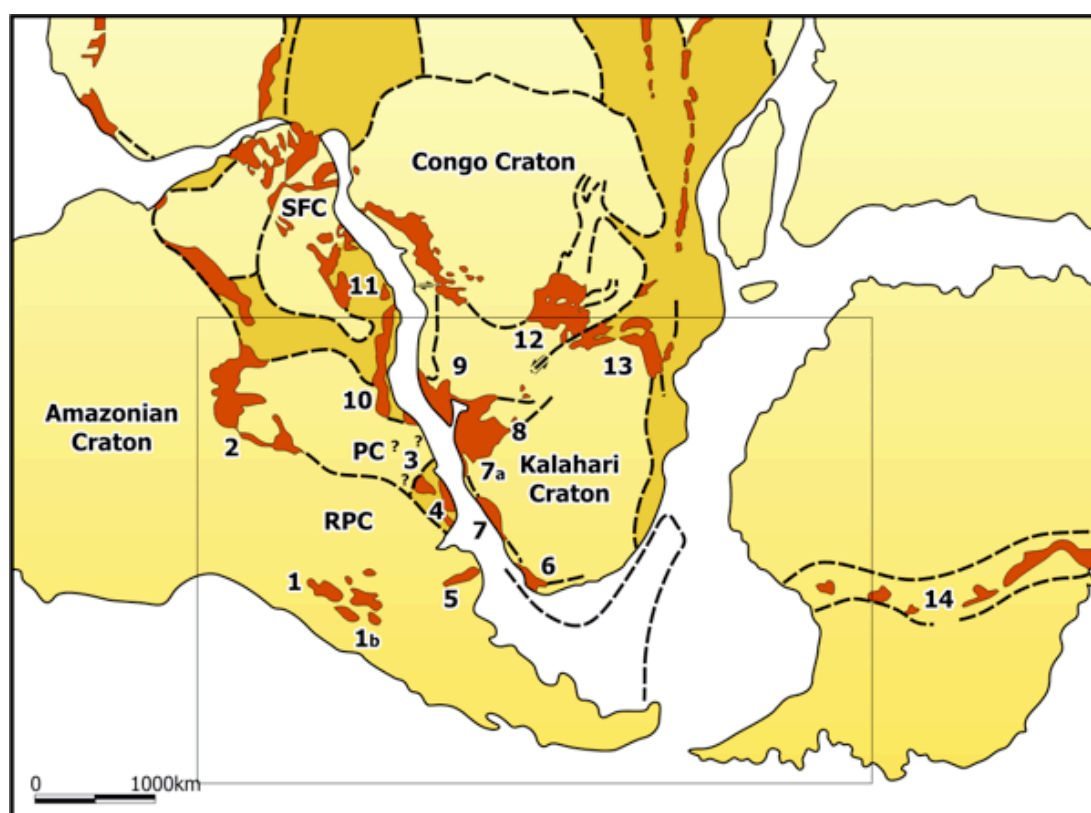


Figure 1: Studied units indicated on a pre-drift reassembly of Gondwana, modified after Porada (1989). PC: Paraná Craton, RPC: Río de la Plata Craton; SFC: Sao Francisco Craton. Red areas: Neoproterozoic to Early Palaeozoic belts and deposits. 1: Sierras Pampeanas Belt, 1b: Cordillera Frontal Metamorphic Belt, 2: Paraguay Belt, 3: Dom Feliciano Belt, 4: Arroyo del Soldado Group, 5: Tandilia System, 6: Saldania Belt, 7: Gariep Belt, 7a: Nama Group, 8: Damara Belt, 9: Kaoko Belt, 10: Ribeira Belt, 11: Aracuaí Belt, 12: Lufilian Belt, 13: Zambezi Belt, 14: Transantarctic Belt (only the most significant units for the present project have been indicated)

that the Cuchilla Dionisio-Pelotas Terrane is an allochthonous block attached to the Río de la Plata Craton in the Cambrian. First detrital zircon data for the Rocha Group, a unit occurring in the Cuchilla Dionisio-Pelotas Terrane, indicated a possible link of this lithostratigraphic unit with the Oranjemund Group of the Gariep Belt (Frimmel et al., 2003, Fig. 1). A comprehensive study of megashear zones in Brazil by Sadowski & Campanha (2004) contributed towards understanding the

Neoproterozoic tectonic evolution of the area. Significant advances have been also achieved in understanding the tectonic evolution of the Brasilia Belt (Valeriano et al., 2004).

According to Silva et al. (2005), the Brasiliano/Pan African system of orogens record three orogenic systems, namely:

- Brasiliano I, comprising juvenile intraoceanic arcs with collisional climaxes at 790 Ma (Embú Domain) and 730-700 Ma (São Gabriel Orogen)
- Brasiliano II, with collisional climax at 640-620 Ma (Dom Feliciano Orogen) and 600 Ma (Paranapiacaba and Rio Pien orogens).
- Brasiliano III climaxes are bracketed between 590–560 Ma (Araçuaí Orogen) and 520–500 Ma (Búzios Orogen).

Each of these stages actually represent important tectonomagmatic events in the protracted evolution of the large Brasiliano/Pan African orogenic system. Silva et al. (2005) also present evidence in favour of a correlation of the northernmost Araçuaí Orogen and the West Congo Orogen, both formed during the Brasiliano III stage. An important paper on the event geochronology of the Kaoko Belt in Namibia by Goscombe et al. (2005) confirms three distinct tectono-metamorphic events, which match the Brasiliano II and III events of Silva et al. (2005).

Basei et al. (2005) report U-Pb datings of detrital zircons from the Neoproterozoic Port Nolloth, Oranjemund and Rocha Groups (Namibia and Uruguay, Fig. 1). A striking similarity between the detrital zircon populations of the upper Oranjemund Group in southwestern Namibia and the Rocha Group in eastern Uruguay is observed. The most prominent peaks are centered around 600 Ma, 1000 Ma and 1700-2000 Ma in both samples. Whereas maximum age of the upper Oranjemund Group is constrained by the youngest detrital zircons of 609 ± 17 Ma, the Rocha Group must have been deposited between 629 ± 17 Ma and 550 Ma (Rb-Sr age of the intrusive Santa Teresa Granite). The data presented by Basei et al. (2005) suggest that the upper Oranjemund and the Rocha Groups are coeval (Ediacaran), and that they were both sourced from the Kalahari Craton. This has important palaeogeographic implications, supporting an allochthonous character and African affinity for the Cuchilla Dionisio-Pelotas Terrane, as proposed by Bossi & Gaucher (2004).

Blanco & Gaucher (2005) postulate a rift setting for Las Ventanas Formation of Uruguay, which according to acritarch biostratigraphy and available datings was deposited in the early Ediacaran (ca. 600 Ma). This rifting event is associated to the emplacement of the Nico Pérez Mafic Dyke Swarm (Rivalenti et al., 1995), as well as bimodal basaltic-rhyolitic volcanism of Las Ventanas Formation (Blanco & Gaucher, 2005). The age is significantly younger than rifting events recorded in the Kalahari Craton around 833 ± 2 to 741 ± 6 Ma (Frimmel et al., 2002 and references therein).

Glacial events. A major contribution has been the precise dating of the Ghaub glacial event in the Otavi Group (Hoffmann et al., 2004), which provided the first age constraint (635 Ma) for Marinoan-type glaciation. A number of previously unknown Neoproterozoic diamictite horizons of probable glacial origin have been reported from SWG. They occur in the upper Corumbá Group (Boggiani et al., 2004) and upper Araras Group (Figueiredo et al., 2004). Striated clasts occur in the latter diamictites. Both units are younger than the glaciogenic Puga Formation, which is

probably Marinoan in age in the northern Paraguay Belt (Alvarenga et al., 2004). The first report of a late Neoproterozoic lithostratigraphic unit deposited in an ice-free area (Río de la Plata Craton) during a glacial event was presented by Gaucher et al. (2004b) from the Polanco Formation of Uruguay. The data suggest that Ediacaran glacial events were deposited in non-“snowball Earth” conditions, allowing for ice-free areas in the tropical region. Pazos et al. (2003) present the first evidences of possible Neoproterozoic glacial deposits (Playa Hermosa Formation) from the Río de la Plata Craton.

There is growing evidence, that there are more glacial events represented in SWG than previously thought. Present data allow to preliminary separate the following glacial events:

Event	Proposed name	Age range	Examples in SWG
Kaigas	Kaigas	$<771 \pm 6, >741 \pm 6 \text{ Ma}^1$	Kaigas Fm., Jequitai Fm., Bebedouro Fm.
Sturtian	-----	$717 \pm 4 \text{ Ma to } 684 \pm 4 \text{ Ma}^2$	Chuos Fm., Jacarecica/ Ribeirópolis Fm.
Marinoan	Ghaub	$635 \pm 1 \text{ Ma}^3$	Ghaub Fm., northern Puga Fm., ?Jacadigo Group, ?Palestina Fm.
Gaskiers	Gaskiers	$584 \pm 0.5 \text{ to } 582 \pm 0.4 \text{ Ma}^4$	Southern Puga Fm., Serra Azul Fm.
Moelv	-----	ca. 560 Ma	Numees Fm., Middle Polanco Fm.
Vingerbreek	Vingerbreek	548 Ma^5	Vingerbreek Mb., Barriga Negra Fm., ?basal Guaicurus Fm.
Fersiga	-----	542 Ma	?Nomtsas Fm.

Table 1: Overview of Neoproterozoic glacial events, their absolute ages and examples in southwestern Gondwana (SWG). Sources: ¹Frimmel & Fölling (2004) and references therein, ²Fanning & Link (2004), Lund et al. (2003), ³Hoffmann et al. (2004), ⁴Bowring et al. (2003), ⁵Germis (1974), Grotzinger et al. (1995)

Recent chemostratigraphic data by Sial et al. (2005, see below) and detrital zircon data by Brito Neves & Van Schmus (in Sial et al., 2006) suggest that the Ribeirópolis Formation (Sergipano Belt, northern Sao Francisco Craton, Fig. 1) is of Sturtian age and younger than 720 Ma.

Diamictites filling a prominent karst surface occur in the lower Las Ventanas Formation, with a most probable age between 615 to 580 Ma (Gaucher et al., 2005c). These diamictites of possible glacial origin have been broadly correlated with the Playa Hermosa Formation (Blanco & Gaucher, 2005), providing new evidence for an early Ediacaran glacial event in the Río de la Plata Craton, as suggested by Pazos et al. (2003).

Gaucher et al. (2005a) present biostratigraphic data supporting a Moelv or –less probably- Gaskiers age for the glaciogenic Numees Formation, in agreement with previous Pb-Pb datings of its cap carbonate (555 ± 28 Ma: Fölling et al., 2000), and C and Sr isotopic data (Fölling & Frimmel, 2002). Tuffs deposited near the end of a prominent negative $\delta^{13}\text{C}$ excursion in the upper Doushantuo Formation (China) yielded a precise U-Pb SHRIMP zircon age of 555 ± 6 Ma (Zhang et al., 2005), identical to available ages of the post-Numees cap carbonate. This suggests that a major glacial event occurred after the Gaskiers Glaciation, just prior to 555 Ma. Important differences emerge between the glaciogenic units deposited on the southern Congo Craton (Varianto/Chuoes and Ghaub Formations) and those deposited on the Kalahari Craton in southern Africa. Whereas the former represent the Sturtian and Marinoan events, the latter record the oldest Kaigas Glaciation and the younger Gaskiers or Moelv event.

As for the youngest Neoproterozoic glacial events, there is compelling evidence supporting an upper Ediacaran glacial event, first recognized in the Vingerbreek Member of the Nama Group (Germs, 1974; Germs, 1995 and references therein). Apart from the Vingerbreek Member, examples of large-amplitude regressions associated to negative $\delta^{13}\text{C}$ excursions and post-dating *Cloudina*-bearing carbonates, are known from a number of successions in SWG, including the Barriga Negra Formation of the Arroyo del Soldado Group (Gaucher et al., 2004a) and the lower Guaicurus Formation of the Corumbá Group, where a distinct diamictite level occurs (Boggiani et al., 2004). According to the correlations proposed by Gaucher et al. (2005b), the prominent karst surface developed on top of the Loma Negra Formation (Sierras Bayas Group) is at the same stratigraphic level as the mentioned units and might represent sea-level fall associated with the Vingerbreek glacial event.

This scheme indicates that the Neoproterozoic Glacial Era lasted for more than 200 My, and unambiguously affected tropical areas of SWG, as indicated by an increasing amount of palaeomagnetic data. However, the younger glacial events were probably non-global in extent, as demonstrated by ice-free regions in SWG recording all the perturbations typically associated with Neoproterozoic glacial events (Gaucher et al., 2004b, 2005d).

Fieldwork. IGCP 478 made it possible for a large number of researchers to carry out fieldwork in previously poorly-known areas. Apart from the field workshops (2003: Gariép Belt in southern Namibia; 2004: Paraguay Belt in western Brazil, 2005: Damara Belt in northern Namibia; Fig. 1) held together with the annual meetings 2003-2004, field trips were organized to other areas in the first three years of IGCP 478. These include (Fig. 1):

Saldania Belt, South Africa (Malmesbury, Cango Caves, Gamtoos and Kaaimans Groups), Katangan Belt (Roan Group) of Zambia; Nico Pérez Terrane, Uruguay (Fuente del Puma Group, Las Ventanas Formation, Cambrian magmatism); Cuchilla Dionisio Terrane, Uruguay (Rocha Group, Cerros de Aguirre Formation); Tandilia Terrane, Argentina and Uruguay (Sierras Bayas Group and Piedras de Afilar Formation); Pie de Palo Range, Argentina (Caucete Group); Argentine Precordillera (La Laja, Zonda, La Flecha and La Silla Formations) and Sergipano Belt (Miaba and Vaza Barris Groups), NE Brazil.

2.2. Outreach

A documentary film was produced during the first project meeting and field workshop in South Africa and Namibia (October 2003), in cooperation with the Uruguayan national television channel (TVEO). Extra funding was granted by UNESCO to the TV crew for this purpose. This documentary has been exhibited in Uruguayan (2003, 2006) and Brazilian (2004) media. At the same time, aspects of the palaeontology of Vendian fossils (Ediacara Fauna, skeletal fossils and trace fossils) were documented by the TV crew for IGCP Project 493 (“The rise and fall of the Vendian biota”). This video footage is being used as part of the “Beyond the Edge Exhibition” on Ediacaran fossils by IGCP 493, that begun touring in 2005 (Melbourne) and it will open in Japan in July 2006.

During the field workshop in the Paraguay Belt (Brazil) in 2004, media coverage was provided by a TV crew of O’Globo network under the direction of Claudia Geigher. Parts of this footage was exhibited in the “Jornal Nacional” of O’Globo in November 2004 (Brazil).

IGCP 478 is collaborating with Ing. Edgardo Verzi (see below) with the scientific aspects of an art exhibition in La Paloma (Uruguay), named “*Adamastor*”. The exhibition is aimed at exploring artistic aspects of the Neoproterozoic South America-southern Africa connection. It is held at one of the main localities where the Rocha Group crops out, which is the unit recently correlated with the Oranjemund Group of South Africa by Basei et al. (2005).

2.3. Societal benefits

One important societal aspect of IGCP 478 has been the incorporation of several undergraduate and postgraduate students. During 2003 and 2004, four PhD students begun their postgraduate studies within the framework of IGCP 478 at the University of Johannesburg (South Africa) and at the Universidad Nacional de La Plata (Argentina). In 2005 IGCP 478 doubled the number of postgraduate students involved in the project, to a number of eight at four universities (see 3.4).

Further societal benefits arose from cooperation between IGCP 478 and mining (cement, fertilizers, iron-manganese, base metals, gold) and oil companies at different levels in Argentina, Brazil, Namibia, South Africa and Uruguay. Among these companies were: Votorantim, Mineração Corumbaense Reunida (Rio Tinto Group), Dagoberto Barcellos, Loma Negra SA, Cementos Avellaneda SA, Compañía Uruguaya de Cemento Portland SA, Compañía Nacional de Cementos, ANCAP, Rosh Pinah Mine, Circle Oil, PETROBRAS, Kumba Resources, Reuning Mine, NAMDEB, NAMCOR, SASOL, Anglo American and PPC Cement. Several rural areas, strongly dependent on mining and its products, will be favoured, such as Olavarría and San Juan (Argentina), Mato Grosso (Brazil), Rosh Pinah and surroundings (Namibia) and Minas-Pan de Azúcar (Uruguay).

3. Achievements of the project 2006

3.1. List of countries involved in the project (please *indicate the countries active this year)

<i>Country</i>	<i>National coordinator</i>	<i>Participants involved</i>
ARGENTINA*	Prof. Dr. Daniel Poiré	10
AUSTRALIA*	Prof. Dr. Jim Gehling	2
BOTSWANA*	Prof. Dr. Marek Wendorff	1
BRAZIL*	Dr. Jane Nobres	22
CANADA*	-----	4
CHILE*	-----	2
FINLAND*	Dr. Toni T. Eerola	1
GERMANY*	Dr. Andreas Braun	9
GREAT BRITAIN	Dr. Tony Prave	1
NAMIBIA*	Karl-Heinz Hoffmann	5
RUSSIAN FEDERATION	Prof. Dr. Mikhail Fedonkin	1
SOUTH AFRICA*	Prof. Dr. Hartwig Frimmel	17
SWITZERLAND*	Dr. Jorge Spangenberg	3
UNITED STATES OF AMERICA*	Dr. Dan Condon	7
URUGUAY*	Dr. Claudio Gaucher	16
ZIMBABWE	Seedwel Ravengai	1
TOTAL: 16 Countries		102

3.2. General scientific achievements (including societal benefits)

(Meetings are not considered as scientific achievements, they should be listed under heading 3.3.)

3.2.1 Scientific achievements

3.2.1.1-Brief summary of advances made in 2006

Chemostratigraphic events. New chemostratigraphic data were reported in 2006 from the following units:

-Alvarenga et al. (2006) report C and Sr isotopic data from a deep borehole (2-SM-MT, TD=5.779 m) drilled through the Parecis Basin, which is located on the Amazonian Craton in western Brazil. Two Neoproterozoic carbonate sequences separated by diamictites and shales occur there. Whereas the lower carbonates yielded $\delta^{13}\text{C}$ values between -1.7 and $+5.0$ ‰ PDB and $^{87}\text{Sr}/^{86}\text{Sr}$ values between 0.7071 and 0.7075, the upper carbonates are characterized by $\delta^{13}\text{C}$ between -0.1 and -6.9 ‰ PDB and $^{87}\text{Sr}/^{86}\text{Sr}$ of 0.7078 (Alvarenga et al., 2006). The authors correlate this carbonate units with the Araras Group and the Serra Azul Formation respectively, for which new chemostratigraphic data were provided by Figueiredo et al. (2006) and Riccomini et al. (2006).

-Significant advances were made in the chemostratigraphy of the Neoproterozoic Estância/Miaba and Vaza Barris Groups (Sergipano Belt, NE Brazil). Sial et al. (2006) report high resolution C and O isotopic data, $\delta^{13}\text{C}$ varying between -5 and $+9$ ‰ PDB.

-Misi et al. (2006) report $\delta^{13}\text{C}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ values for phosphorites and carbonates of the Una Group (São Francisco Craton, Brazil). $\delta^{13}\text{C}$ values show a large scatter between -12.3 and $+9.5$ ‰ PDB. $^{87}\text{Sr}/^{86}\text{Sr}$ values range between 0.7066 and 0.7091 in the phosphorites, and between 0.7076 and 0.7089 in interbedded limestones.

These data provide chemostratigraphic evidences in favour of a correlation of phosphorite beds of the Una Group with those of the Vazante and Bambuí groups (Misi et al., 2006). A Cryogenian age is consistent with both $\delta^{13}\text{C}$ and $^{87}\text{Sr}/^{86}\text{Sr}$ values obtained.

-Pamoukaghlian et al. (2006) report the first $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ analyses of carbonates from the uppermost Piedras de Afilas Formation (Piedra Alta Terrane, Uruguay). $\delta^{13}\text{C}$ values are very consistently clustered around +5.1 to +5.8 ‰ PDB. Although not diagnostic alone, these values allow to rule out a correlation with the Cerro Victoria Formation (Nico Pérez Terrane, Uruguay), and are also consistent with a Neoproterozoic age for the Piedras de Afilas Formation (see also “palaeogeography” below).

-Frimmel et al. (2006) report for the first time chemostratigraphic data for carbonates of the West Congolian Group in the Democratic Republic of Congo.

Biostratigraphy and palaeobiological events

The main focuses of biostratigraphic research in 2006 were the Saldania Belt (South Africa), the Mina Verdún Group (Uruguay) and the Puncoviscana Formation (Argentina).

-Three successive acritarch assemblages were reported by Gaucher & Germs (2006) from the Cango Caves and Gamtoos groups of the Saldania Belt, from base to top: *Bavlinella faveolata* assemblage, *Soldadophycus* assemblage and *Leiosphaeridia* assemblage. A biostratigraphic correlation between both units at the formational level was proposed on the basis of these microfossils by Gaucher & Germs (2006). The organic-rich limestones hosting *Bavlinella faveolata*-dominated assemblages seems to represent an important event of ocean eutrophication previous to the Numees glacial event (Gaucher et al., 2005a).

-Gymnosolenid, digitate, columnar stromatolites were reported by Poiré et al. (2006) from the Gibraltar Formation of the Mina Verdún Group, Uruguay. This stromatolite assemblage overlies a *Conophyton*-dominated stromatolite assemblage (El Calabozo Formation), suggesting a shallowing-upward trend. Gaucher et al. (2006a) suggest that the age of the Mina Verdún Group is late Mesoproterozoic to Tonian, on the basis of high-resolution carbon isotopes stratigraphy.

-Aceñolaza & Aceñolaza (2006) provide a taxonomical reevaluation of *Nereites saltensis* from the Puncoviscana Formation, NW Argentina.

Glacial events

The subject of Neoproterozoic glaciations continues to be hotly debated regarding the number, extent, causes and consequences of the glacial events. Two main areas were the subject of research in 2006 regarding Neoproterozoic glaciations: the Paraguay Belt (Brazil) and the Nico Pérez Terrane (Uruguay).

Paraguay Belt. Boggiani et al. (2006) report banded iron formations (BIF) up to 50 m thick associated with glacial diamictites of the Puga Formation (SW-Brazil). The BIF contain 46 % Fe_2O_3 and 46 % SiO_2 , and are characterized by granitic dropstones that disrupt the original banding (Boggiani et al., 2006). The Puga Formation and

associated BIF were probably deposited during the latest Neoproterozoic glacial events (Ghaub or Gaskiers), because they are overlain by *Cloudina*-bearing limestones with no evident hiatuses in between.

Babinski et al. (2006) present Pb-Pb datings of cap carbonates overlying the Puga Formation in the northern Paraguay Belt (Brazil), yielding an age of 627 ± 32 Ma. This is more consistent with the Puga Formation there being coeval to the Ghaub glacial event (Hoffmann et al., 2004). Ash beds interbedded with *Cloudina*-bearing carbonates in the Corumbá Group (southern Paraguay Belt) yielded U-Pb zircon ages ranging from the Palaeo- to the Neoproterozoic. The least discordant data yielded a weighted-mean age of 545 ± 6 Ma (Babinski et al., 2006). However, zircons from an ash bed 45 cm above yielded a weighted-mean U-Pb age of 570 ± 11 Ma, so far preventing a meaningful interpretation of these data (Babinski et al., 2006).

Figueiredo et al. (2006) confirm the occurrence of two glaciogenic diamictite horizons in the northern Paraguay Belt: the Puga Formation and the Serra Azul Formation, separated by thick carbonates of the Araras Group. Each of these glacial diamictites is overlain by cap carbonates yielding negative $\delta^{13}\text{C}$ values. Whereas the lower cap carbonate (Guia Formation) shows $^{87}\text{Sr}/^{86}\text{Sr}$ values between 0.7075 and 0.7078, the upper cap carbonates (Serra Azul Formation) yielded $^{87}\text{Sr}/^{86}\text{Sr}$ ratios between 0.7086 and 0.7088. This led Figueiredo et al. (2006) to suggest that the Puga Formation is correlative to the Ghaub glacial event, and the Serra Azul diamictites to the Gaskiers glacial event.

Nico Pérez Terrane. Previously unknown glaciogenic diamictites, including dropstone-rich siltstones, were described for the lower Las Ventanas Formation of the Nico Pérez Terrane, Uruguay (Gaucher et al., 2005c, 2006a, in press).

Loureiro et al. (2006) describe glacial features, including diamictites, BIF and dropstones, from the Zanja del Tigre Formation (Nico Pérez Terrane, Uruguay), which they assign to the Neoproterozoic. However, U-Pb SHRIMP detrital zircon ages reported by Basei et al. (2006) for metasandstones of the Zanja del Tigre Formation show prominent peaks at 3.4, 2.7 and 2.2 Ga, the youngest zircon being Palaeoproterozoic in age. Given that an associated, conspicuous granitic magmatism has been confidently dated at 1750 Ma (U-Pb SHRIMP: Mallmann et al., 2003; U-Pb: Sánchez Bettucci et al., 2004), the Zanja del Tigre Formation was probably deposited between 2.2 and 1.75 Ga. Therefore, glacial deposits described by Loureiro et al. (2006) probably record Palaeoproterozoic glaciation.

The timing and number of glacial events continues to be a controversial issue, mainly because of the lack of reliable geochronological data for a representative sample of Neoproterozoic glacial units. On the other hand, the available data allow the following conclusions:

(a) The Marinoan glaciation in its type area in Australia and correlative units in Tasmania is probably younger than previously assumed. A depositional age between 582 ± 4 and 575 ± 3 Ma is indicated by U-Pb SHRIMP ages of volcanic and subvolcanic rocks in Tasmania (Calver et al., 2004), and Re-Os ages in the Amadeus Basin (Schaefer & Burgess, 2003). This makes a correlation with the Gaskiers glacial event (584 ± 0.5 to 582 ± 0.4 Ma, Bowring et al., 2003) more probable than a correlation with the significantly older Ghaub (635 ± 1 Ma, Hoffmann et al., 2004) or Chuos events (635.2 ± 0.6 , Condon et al., 2005). On this basis, usage of the term “Ghaub Glacial Event” seems more appropriate to designate the glacial event that ended around 635 Ma (Table 1). Because of the uncertainties regarding the age of the Marinoan in its type area, usage of this stratigraphic term is regarded as problematic.

(b) The precise age of the Sturtian glaciation is also uncertain. Fanning (2006) reports U-Pb SHRIMP ages of zircons from a tuffaceous band within the Merinjina Formation (Southern Australia), suggesting an age of 659 ± 6 Ma for the volcanic zircons and thus for the maximum depositional age of the unit. Re-Os ages of overlying shales (Tindelpina Formation) suggest a minimum age of 645 Ma. These ages are significantly younger than other “Sturtian” deposits, mostly within 717 and 684 Ma (Fanning & Link, 2004). It is not clear how the lower Cryogenian deposits in SWG (Chuos, Kaigas, Bebedouro, Jequitai, Jacarecica/ Ribeirópolis formations) relate to these events. Pb-Pb datings of cap carbonates (Sete Lagoas Formation) related to the Jequitai Formation yielded an age of 740 ± 20 Ma (Babinski et al., 2006), thus significantly older than the data reported by Fanning (2006) and Fanning & Link (2004).

Palaeogeography and tectonomagmatic events

Significant advances have been made in 2006 regarding the palaeogeography of the Río de la Plata Craton and adjacent areas. Gaucher et al. (2006b) report U-Pb (LA-ICP MS) ages of detrital zircons from sedimentary covers of the Río de la Plata Craton: the late Neoproterozoic Sierras Bayas Group (Tandilia, Argentina; Fig. 1), Arroyo del Soldado Group (Nico Pérez Terrane, Uruguay; Fig. 1) and Piedras de Afilar Formation (Tandilia Terrane, Uruguay). Quartz-arenites of the Piedras de Afilar Formation show typical Transamazonian ages, with peaks at 2.07, 1.87 and 1.78 Ga. However, the most important zircon population is Mesoproterozoic, showing maxima at 1.49, 1.35, 1.25 and 1.0 Ga (Gaucher et al., 2006b). Archean zircons are subordinate. Zircons recovered from two sandstone levels in the Arroyo del Soldado Group (Yerbal and Cerros San Francisco formations) are mostly Archean in age, with maxima at 3.2 and 2.7 Ga. Palaeoproterozoic zircons are also prominent in this unit, with peaks at 2.45 and 2.19, with the latter a typical Transamazonian age. Whereas one sample from the Sierras Bayas Group (Villa Mónica Formation) show show a unimodal zircon population of Transamazonian age (peak at 2.14 Ga), Sandstones of the Cerro Largo Formation are characterized by a dominant Transamazonian zircon population (peaks at 2.15, 2.0 and 1.79), but also important Archean-lowermost Palaeoproterozoic (3.33, 2.99, 2.7, 2.47 Ga) and Mesoproterozoic peaks (1.56, 1.24 and 1.07). The conspicuous absence of Neoproterozoic zircons confirm other lines of evidence suggesting that the studied units were deposited in a stable continental margin, and that only the Cambrian Cabo Frío Orogeny affected the Río de la Plata Craton (Bossi & Gaucher, 2004). The abundance of Mesoproterozoic detrital zircons is surprising, and very characteristic (various peaks between 1.56 and 1.0 Ga). The marked difference with detrital zircon populations reported from the Ediacaran Rocha Group in Uruguay (Basei et al., 2005), reinforces previous suggestions of an African affinity for this unit (Basei et al., 2005; Frimmel & Basei, 2006). Detrital zircon ages reported by Basei et al. (2006) from the Porongos and Brusque complexes in southern Brazil differ from the sedimentary covers of the Río de la Plata Craton because (a) Archean zircons are largely absent, and (b) Neoproterozoic zircons between 890 and 620 Ma are common. However, the characteristic Transamazonian signature (2.2-1.9 Ga) is present in these units (Basei et al., 2006).

Finney et al. (2006) report U-Pb (LA-ICP MS) detrital zircon ages from 24 Cambrian to Devonian sandstones in Cuyania/Precordillera (Argentina), which are dominated by a Mesoproterozoic population of 1600-1000 Ma with two prominent

peaks at ~1400 Ma and ~1050 Ma. Most samples also include a conspicuous late Neoproterozoic to early Cambrian population (600-500 Ma) and several grains of varied Paleoproterozoic and Archean ages. The Mesoproterozoic signature is almost identical to that found in Neoproterozoic successions of the Río de la Plata Craton (Gaucher et al., 2006b), suggesting that Cuyania/Precordillera might actually be para-auchthochtonous and not of Laurentian affinity. Naipauer et al. (2006) report U-Pb LA-ICP MS datings of detrital zircons from the Caucete Group (Pie de Palo Range, Argentina, yielding predominantly Mesoproterozoic ages between 1471 and 1050 Ma, the most important peak being between 1471 and 1313 Ma. The affinity with the signature reported for the Río de la Plata Craton is notable (Finney et al., 2006; Gaucher et al., 2006b).

Oyhantçabal et al. (2006) report Ar-Ar and Pb-Pb ages for a number of granitoids in Uruguay, which suggests an important magmatic event around 580 Ma. For the Nico Pérez Terrane, this magmatism has been interpreted as related to an extensional environment by Blanco & Gaucher (2005), as suggested by K-Ar ages of the Nico Pérez Mafic Dyke Swarm of 581 ± 13 Ma (Rivalenti et al., 1995).

3.2.1.2-Edition of thematic issues of journals and book

- 1) A thematic issue of the journal *Chemical Geology* was edited by Kaufman, A.J; Sial, A.N. and Ferreira, V.P., and is now in press. Originally, it was scheduled to appear in 2006, but it was delayed due to reasons not related to IGCP 478. It contains an important number of papers dealing with chemostratigraphy of Neoproterozoic to Cambrian successions in SWG.
- 2) Thomas Fairchild (USP, São Paulo), Renata Schmitt (UERJ, Rio de Janeiro) and Hartwig Frimmel (Universität Würzburg/ University of Cape Town) finished editing a thematic issue of *Gondwana Research*, mainly composed of papers presented at the 1st Symposium Neoproterozoic-Early Palaeozoic Events in SW-Gondwana (São Paulo, 2004). The volume encompasses 12 papers, and was scheduled to appear in July 2006 as Vol. 9, No. 3 of the mentioned journal. However, it will effectively appear in 2007.
- 3) The publication of a book about “*Events at the Precambrian-Cambrian boundary in southwestern Gondwana*“ is being organized by Gaucher, C., Sial, A.N., Halverson, G.P. and Frimmel, H.E. as book editors. It will summarize the results of IGCP 478, and has been offered to Elsevier (*Developments in Precambrian Geology* series). Series editor, Prof. Kent Condie, already gave his approval. Positive reviews were provided by three referees to Elsevier. Final modifications to the book structure are currently being made to meet the reviewers’ suggestions, and final approval from Elsevier is expected in the next weeks.

3.2.2 Outreach

In Uruguay, collaboration of IGCP 478 with the “*Adamastor*” project (Coordinator: E. Verzi, website: www.edgardooverzi.com) comprised two lectures of C. Gaucher

about “The Rocha Group: a piece of Africa in South America”. The lectures, aimed at the general public, were given in La Pedrera on the 17th January 2006 (La Pedrera) and on the 27th September 2006 (Montevideo). A short documentary film was shot by Daniel Amorín and Claudia Nartallo, explaining the geology of the Rocha Group and the palaeogeographic evolution of SW-Gondwana in the Neoproterozoic-Cambrian, as well as artistic aspects related to the beautiful rock exposures of the unit.

Related to the previous activities is a collaboration between IGCP 478 and the Club de Fomento of La Pedrera (Rocha Department, Uruguay). Renata Schmitt (UERJ, Brazil), Jorge Bossi (Facultad de Agronomía, Uruguay) and Claudio Gaucher (Facultad de Ciencias, Uruguay) advised this institution about the construction of a geoturistic path on rocks of the Rocha Group in La Pedrera. A graduate student from the Facultad de Ciencias (Joaquín Cabrera) is also participating in this project under the supervision of C. Gaucher.

3.2.3 Societal benefits

In 2005 IGCP 478 reached the number of ten postgraduate students involved in the project, based at five universities in four countries (see 3.4). A number of them will finish their dissertations next year, in time to contribute to the synthesis of the project results to be published in the “Developments in Precambrian Geology” series. All this postgraduate students come from developing countries in Africa and South America.

Collaboration with mining (cement, fertilizers, iron-manganese, base metals, gold) and oil companies continued in 2006. Among these companies in Argentina, Brazil, Namibia, South Africa and Uruguay were: Votorantim, Mineração Corumbaense Reunida (Rio Tinto Group), Dagoberto Barcellos, Cementos Avellaneda SA, Compañía Uruguaya de Cemento Portland SA, Compañía Nacional de Cementos, ANCAP, Rosh Pinah Mine, Circle Oil, PETROBRAS, Kumba Resources, Reuning Mine, NAMDEB, NAMCOR, SASOL, Anglo American and PPC Cement. Several rural areas, strongly dependent on mining and its products, will be favoured, such as Olavarría and San Juan (Argentina), Mato Grosso (Brazil), Rosh Pinah and surroundings (Namibia), Minas and Pan de Azúcar (Uruguay).

3.3. List of meetings with approximate attendance and number of countries

In 2006, one meeting with two field workshops were planned within the activities of IGCP 478. The meeting was held in April in Punta del Este (Uruguay), within the V. South American Symposium of Isotope Geology. Pre-symposium fieldwork was carried out in Tandilia (Argentina) and in the Nico Perez Terrane. A post-symposium field workshop was carried out in the Puncoviscana Formation in northwestern Argentina. The details of the meeting and field workshops are given below.

3.3.1- V. South American Symposium of Isotope Geology, V SSAGI (4th IGCP 478 annual meeting)

Over two hundred participants from twelve countries (Fig. 2) attended the V. South American Symposium of Isotope Geology (V SSAGI), and 155 contributions were presented. A short papers volume was printed (550 printed pages) containing all

contributions. Additionally, a volume of abstracts with programme was printed, comprising 64 pages.

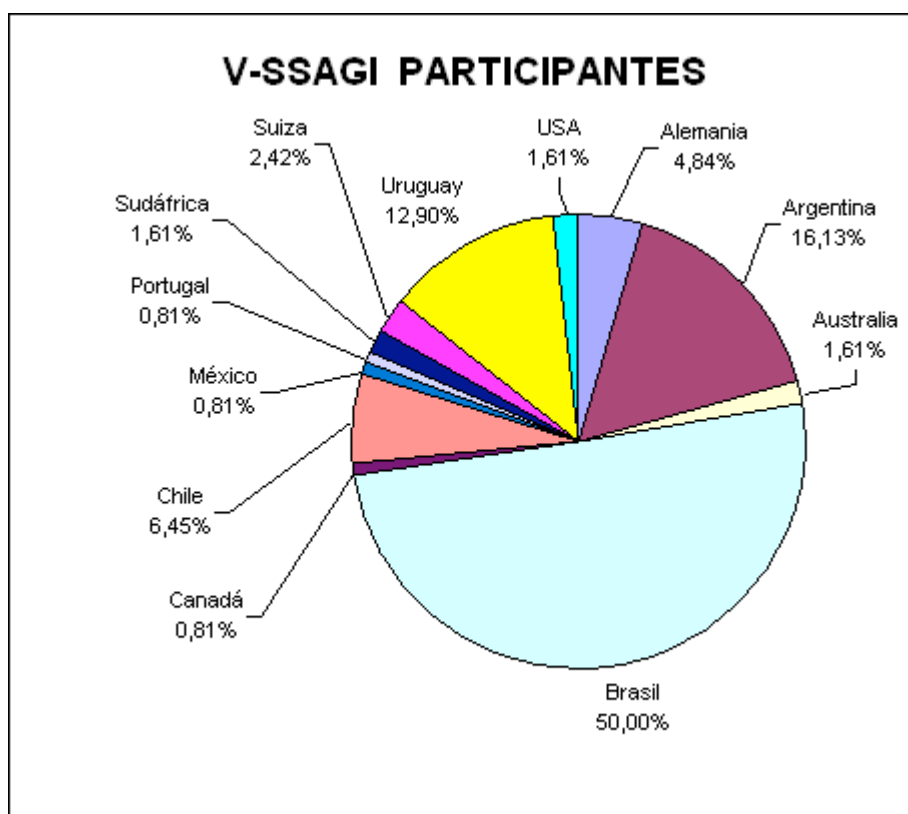


Figure 2: Pie graph showing where the researchers attending V SSAGI are based

From the grand total of 155 contributions, twenty-five were presented by project members as contribution to the IGCP 478 annual meeting. Forty-three members of project IGCP 478 from ten countries (see below) attended the symposium, and twenty-one researchers participated in the field workshops

The following table gives an overview of researchers attending the meeting:

Summary of IGCP 478 members attending the meeting

Country	Institutions	Number of participants
ARGENTINA	Universidad de Tucumán	2
	Universidad Nacional de La Plata	4
AUSTRALIA	Australian National University	1
GERMANY	Universität Göttingen	4
	Universität Würzburg	1
BRAZIL	Universidade de São Paulo	6
	Universidade Federal de Pernambuco	3
	Universidade de Brasilia	2
	Universidade Estadual Rio Janeiro	2
	Universidade Federal da Bahia	1
CANADA	Carleton University	1
CHILE	Universidad de Chile	1

SOUTH AFRICA	University of Johannesburg	2
SWITZERLAND	Université de Lausanne	2
	Universität Bern	1
UNITED STATES OF AMERICA	University of Maryland	1
	Circle Oil Plc	1
URUGUAY	Universidad de la República	7

Three project meetings were successfully carried out on the 24th, 25th and 27th April, during which project-related issues were discussed. The main outcomes of these project meetings were the following:

- (a) The fifth and last project meeting will be held in August-September 2007 at the University of Stellenbosch, South Africa. The organizers are Prof. Abraham Rozendaal and Prof. Gerard J.B. Germs. A pre-symposium fieldtrip to the Neoproterozoic to Cambrian successions in the Saldania Belt will be carried out possibly after the meeting (duration: 5 days).
- (b) It was agreed upon the submission of a proposal to Elsevier (*Developments in Precambrian Geology* series) about a book on “Events at the Precambrian-Cambrian boundary in southwestern Gondwana“. Authors were assigned to the different chapters, and a book structure worked out. After the meeting, this proposal was submitted to the series Editor, Prof. Kent Condie, who gave his approval. The book is intended to summarize the results obtained during IGCP 478, present an updated summary of the different events in the Neoproterozoic and Cambrian, and discuss the events recorded in SW-Gondwana in the light of the global trends.
- (c) Deadline for submission of manuscripts for the book will be May 1st, 2007. The synthesis chapters at the end of the book will be finished after thorough discussion of the available data during the fifth project meeting next year in South Africa. All manuscripts should be finished and reviewed by the end of April 2008.

3.3.2 Pre-Symposium Field Workshop: Neoproterozoic-Early Palaeozoic sedimentary successions of the Río de la Plata Craton

Fieldwork took place between the 17th and 23rd April 2006, departing from Buenos Aires (Argentina) and ending at Punta del Este (Uruguay). Field trip leaders were Prof. Daniel Poiré and Dr. Claudio Gaucher.

The field trip aimed to introduce the participants to the litho-, bio- and chemostratigraphy of lithostratigraphic units deposited on the Río de la Plata Craton in Uruguay (Nico Pérez Terrane) and Argentina (Tandilia). These units are the Sierras Bayas Group, Cerro Negro and Balcarce Formations (Argentina), Mina Verdún Group, Las Ventanas Formation and Arroyo del Soldado Group (Uruguay).

Fifteen researchers from five countries attended the field workshop (see table below). Outcrops visited were in the vicinity of Olavarría, Tandil, Barker and Mar del Plata in Argentina, and around Pan de Azúcar, Minas, Nico Pérez and Treinta y Tres in Uruguay. On-site discussion of the palaeoclimatology, geotectonic evolution and possible correlation with units on the southern African side and elsewhere was one of the major goals of the field workshop. A detailed fieldtrip guide (attached to this report) was prepared and distributed to participants. The opportunity was used by PhD students sponsored by IGCP 478 to collect samples for isotopic studies,

organic geochemistry, micropalaeontology and radiochronology, thus enhancing the potential results of the field trip.

Detailed list of participants-Pre symposium field trip

Name	Institution	Country	Address
Carlos Alvarenga	Universidade de Brasilia	Brazil	alval@unb.br
Marly Babinski	Universidade de São Paulo (USP)	Brazil	babinski@usp.br
Paulo C. Boggiani	Universidade de São Paulo (USP)	Brazil	boggiani@usp.br
Federico Cernuschi	Facultad Ciencias, Montevideo	Uruguay	fcernuschi@fcien.edu.uy
Marcel A. Dardenne	Universidade de Brasilia	Brazil	marceldardenne@yahoo.fr
Milene Figueiredo*	Universidade de São Paulo (USP)	Brazil	mimff@hotmail.com
Claudio Gaucher	Facultad Ciencias, Montevideo	Uruguay	gaucher@chasque.net
Lucía Gómez Peral*	Universidad Nacional La Plata	Argentina	lperal@cig.museo.unlp.edu.ar
Alan J. Kaufman	University of Maryland	USA	kaufman@geol.umd.edu
Kevin J. Lant	Circle Oil Plc	USA	klant@circleoil.com
Gabriela Martínez	Facultad Ciencias, Montevideo	Uruguay	gabumart@hotmail.com
Karina Pamoukaghlian*	Universidad Nacional La Plata	Argentina	Karina_pamoukaghlian@hotmail.com
Daniel G. Poiré	Universidad Nacional La Plata	Argentina	poire@cig.museo.unlp.edu.ar
Jorge Spangenberg	Université de Lausanne	Switzerland	Jorge.Spangenberg@unil.ch
Mariluz Velásquez*	Université de Lausanne	Switzerland	Marilu.Velasquez@unil.ch

*PhD students sponsored by IGCP 478

3.3.3 – Post-Symposium Field Workshop: Late Neoproterozoic-Cambrian of northwestern Argentina.

Fieldwork took place between 29th April and 2nd May 2006, departing and ending in the city of Tucumán (Argentina). In the morning of the 29th April, Neoproterozoic to Cambrian fossil collections deposited at the INSUGEO (Instituto Superior de Correlación Geológica) were displayed, and their significance discussed. During the field trip, classical Neoproterozoic/Cambrian localities of the Puncoviscana Formation, and the Mesón and Santa Victoria Groups (Cambrian / Ordovician) in the Andean range were visited, as well as associated granitic intrusions (i.e. Tastil Granite).

The localities studied were the following:

29th April: Revision of the Neoproterozoic / Early Cambrian fossil collections of the Puncoviscana Formation housed at the INSUGEO. Outcrops of the Puncoviscana

Formation in San Javier and Choromoro localities. Night in Tucumán city.
Distance travelled: 150 km.

30th April: Trip to Jujuy. Limestones of Volcán (Neoproterozoic?) and the Tilcara unconformity in the Quebrada de Humahuaca (separates the Puncoviscana Formation -Neoproterozoic/Early Cambrian- from the Mesón Group -Cambrian). Night in Maimará Town (2.300 m.a.s.l). Distance travelled: 500 km.

1st May: Visit to the fossiliferous outcrops of Purmamarca with preserved *Beltanelloides* sp. Outcrops of San Antonio de Los Cobres Village (dominated by the trace fossil *Oldhamia* and biomat-induced structures). Outcrops at Altos de Lipán (4.100 m.a.s.l.). The Puncoviscana Formation at Quebrada del Toro, including Chorrillos (with red facies) and El Alisal localities. Night in Salta City. Distance travelled: 350 km.

2nd May: Visit to the Neoproterozoic ? – Early Cambian Las Tienditas Formation (limestones), and Escoipe locality with ripple mark surfaces, and relatively shallow facies within the Puncoviscana Formation. Distance travelled: 350 km.

Ten researchers from five countries took part in this field trip. A detailed field trip guide was prepared and distributed to participants (attached). The main outcomes of the field workshop in NW-Argentina was the discussion of the palaeogeographic significance of the Puncoviscana Formation in the regional framework of southwestern Gondwana. The importance of the rich Ediacaran to Cambrian ichnoassemblage of the Puncoviscana Formation, especially with regard to the establishment of the Proterozoic-Cambrian boundary, was reassessed.

Detailed list of participants - Post-symposium field trip

Name	Institution	Country	Address
Gilberto Aceñolaza	Universidad Nacional Tucumán	Argentina	insugeo@csnat.unt.edu.ar
Guillermo Aceñolaza	Universidad Nacional Tucumán	Argentina	acecha@webmail.unt.edu.ar
Carlos Alvenga	Universidade de Brasilia	Brazil	alval@unb.br
Marcel A. Dardenne	Universidade de Brasilia	Brazil	marceldardenne@yahoo.fr
Malte Drobe*	Universität Göttingen	Germany	MalteDrobe@gmx.de
Claudio Gaucher	Facultad Ciencias, Montevideo	Uruguay	gaucher@chasque.net
Gerard J.B. Germs	University of Johannesburg	South Africa	gagerms@global.co.za
Eric Gómez Hasselrot	Universidad Nacional Tucumán	Argentina	
Andree Steenken	Universität Göttingen	Germany	asteenk@gwdg.de
Franco Tortello	Universidad Nacional de La Plata	Argentina	tortello@museo.fcnym.unlp.edu.ar

*PhD student

3.4. Educational, training or capacity building activities

The following **postgraduate (PhD*) students** are currently carrying out their research within the framework of IGCP 478:

Name	Institution	Theme of dissertation
Gonzalo Blanco*	University of Johannesburg	Provenance of the Nama and Arroyo del Soldado Group, SW-Gondwana
Leticia Chiglino	Universidade Federal de Pernambuco	Chemostratigraphy of carbonate successions in the southern Nico Pérez Terrane, Uruguay
Milene Figueiredo*	Universidade de São Paulo	Geochemistry and stratigraphy of the northern Paraguay Belt
Lucía Gómez Peral*	Universidad Nacional de La Plata	Diagenesis of the Sierras Bayas Group, Tandilia, Argentina
Tanusha Naidoo	University of Johannesburg	Provenance of the Neoproterozoic Congo Caves and Gamtoos Groups, South Africa
Maximiliano Naipauer*	Universidad Nacional de La Plata	Chemostratigraphy and correlations of carbonate successions in the Sierra de Pie de Palo, Argentina
Karina Pamoukaghlian*	Universidad Nacional de La Plata	Sedimentology, stratigraphy and age of the Piedras de Afilar Formation, Uruguay
Anelda Van Staden*	University of Johannesburg	Neoproterozoic diamictites in SW-Gondwana
Mariluz Velasquez*	Université de Lausanne	Molecular and isotopic biogeochemistry of Neoproterozoic sediments from SW-Gondwana: early palaeoclimatic changes and evolution of life
Lucas Warren*	Universidade de São Paulo	Stratigraphy of the Paraguay Belt in Paraguay

The project supported the students in different ways, including the arrangement of analytical facilities, help during field work related to their postgraduate projects and availability of data gathered by IGCP 478.

Several **undergraduate students** are currently participating of research activities within the framework of IGCP 478. These are: Federico Cernuschi, Gabriela Martínez, Joaquín Cabrera (Facultad de Ciencias, Montevideo) and Alessandra Rosa (UFMT, Cuiabá).

3.5. Participation of scientists from developing countries

Around **80%** of scientists involved in IGCP 478 are based in developing countries in Africa and South America. This figure is applicable both to the total number of researchers involved and to participants in field excursions and meetings.

3.6. List of most important publications (including maps)

Bibliography (listed by author in alphabetical order with the most recent work listed first):

Papers in refereed journals and book chapters published 2006 (no papers in press)

Eerola, T. 2006. Neoproterozoic climate changes. Research on southern Brazil (in Finnish, with English summary). *Geologi* 58 (5), 164-174.

Frimmel, H. E., Tack, L., Basei, M. S., and Nutman, A. P., 2006. Provenance and chemostratigraphy of the Neoproterozoic West Congolian Group in the Democratic Republic of Congo. *Journal of African Earth Sciences*, 46, 221-239.

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Note: A special issue of *Chemical Geology* about Precambrian Isotope Stratigraphy contains six articles (Gaucher et al., Misi et al., Nascimento et al., Nogueira et al., Sial et al. and Tewari & Sial), which are direct contributions to IGCP 478. This issue (guest editors: Sial, A.N., Kaufman, A. J., Ferreira, V.P.) was scheduled to appear in 2006, but due to reasons not related to IGCP 478 will appear in early 2007. The papers are already available online as “papers in press”. Another special issue in *Gondwana Research* (guest editors: Fairchild, T.R., Schmitt, R., Frimmel, H.E.) is about to go to the printers and will also appear in 2007. The volume encompasses 12 papers, and was scheduled to appear in July 2006 as Vol. 9, No. 3 of the mentioned journal.

Fieldtrip guides

Poiré, D.G. & Gaucher, C. 2006. Neoproterozoic/Lower Palaeozoic sedimentary successions of the Río de la Plata Craton, Field trip guide. V South American Symposium on Isotope Geology, Punta del Este, pp. 1-54.

Aceñolaza, G.F. 2006. The Puncoviscana Formation of NW Argentina: a review. V South American Symposium on Isotope Geology, Punta del Este, pp. 1-15.

3.7. Activities involving other IGCP projects or the IUGS

Collaboration with IGCP 512 (Neoproterozoic Ice Ages) consisted in a number of joint activities and incorporation of members of both projects in the mailing lists. Dr. Galen P. Halverson, one of the leaders of IGCP 512, accepted to be a co-editor of the book mentioned above. A number of members of IGCP 478 also attended the meetings of IGCP 512.

4. Activities planned

4.1. General goals

The main goal in 2007 will be the edition of the book on “*Events at the Precambrian-Cambrian boundary in southwestern Gondwana*“, which will be the synthesis of all data gathered by IGCP 478 members since 2003. Apart from the mere enumeration of all the available data, we intend to discuss the interaction between the different events (tectonic, biogeochemical, palaeobiologic, climatic) to gain insight into the processes influencing long-term climate change, organismic evolution and the chemistry of ocean and atmosphere.

For this purpose, a large number of researchers will contribute as authors or editors. The 2007 meeting in Stellenbosch (South Africa) will serve three different purposes: (a) allowing the presentation of the latest results, (b) serve as a forum for the discussion of the synthesis chapters of the book, and (c) show the participants the geology of the Saldania Belt.

4.2. Specific meetings and field trips (please indicate participation from developing countries)

Profs. Abraham Rozendaal and Gerard Germs will be the organizers of the fifth annual meeting, which will take place at the University of Stellenbosch (South Africa) in September 2007. Apart from the scientific sessions of up to three days, a field trip to the Neoproterozoic Saldania Belt will be carried out. This field trip will show the participants the geology of the Cango Caves, Malmesbury, Gamtoos and Kansa groups, as well as granitoids of the Cape Granite Suite.

Projected participation of scientists from developing countries in the meeting and field trips is estimated to exceed 75 %.

5. Project funding requested

The increase in funding for IGCP 478 in its last year is essential to maintain the important momentum that has been achieved, and also to support the successful culmination of the book. It is desirable that the largest possible number of researchers that contribute to the book attend the Stellenbosch meeting. Only this will ensure that a real synthesis emerges, through discussion and interaction between the authors. From the logistical point of view, this means that a larger number of researchers will require funding from IGCP 478.

6. Request for extension, on-extended-term-status, or intention to propose successor project

N/A

7. Financial statement

The IGCP Scientific Board would like to be informed how the IGCP funds were used and if additional funding could be obtained from different sources.

7.1. Summary of usage of IGCP-funds

Funds were used according to the plan submitted early in 2006, and also taking into consideration the recommendations given by the scientific board in its project assessment 2005. It was planned that Prof. Mónica Heilbron (Universidade Estadual Rio Janeiro, Brazil) and Prof. Alan J. Kaufman (University of Maryland, USA)

would receive funding from IGCP 478 to attend the Punta del Este meeting and field trips. Prof. Heilbron could not attend the meeting, and Prof. Kaufman received partial funding from the organization of V SSAGI. Therefore, funds allocated for these researchers (US\$ 400) were redirected to Renata Schmitt (Universidade Estadual Río Janeiro, Brazil; US\$ 100), Hartwig Frimmel (Universität Würzburg, Germany; US\$ 50) and Claudio Gaucher (Facultad de Ciencias, Uruguay; US\$ 50). The rest (US\$ 200) was used to partially cover minibus rental for the pre-symposium field trip to Argentina and Uruguay.

South American Symposium on Isotope Geology – 4th IGCP 478 annual meeting

	Received by (list names)	Country of origin	Allocation (in USD)
Transportation (Long distance)	Carlos Alvarenga	Brazil	250
	Marly Babinski	Brazil	200
	Paulo C. Boggiani	Brazil	450
	Milene Figueiredo	Brazil	250
	Hartwig Frimmel	Germany	450
	Claudio Gaucher	Uruguay	500
	Gerard J.B. Germs	South Africa	700
	Karina Pamoukaghlian	Argentina	250
	Daniel Poiré	Argentina	250
	Renata Schmitt	Brazil	400
	Jorge Spangenberg	Switzerland	300
	Mariluz Velasquez	Switzerland	300
	Subtotal Transportation Expenses		

Field trip transportation expenses	Allocation (in USD)
Minibus rental, pre-symposium field trip (1 invoice)	408, ⁰⁰
Subtotal Field trip transportation Expenses	USD 408,⁰⁰

Organizing Expenses	Allocation (in USD)*
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	24
Website hosting (1 invoice)	100, ⁰⁰
Secretary, organization of IGCP 478 meeting (1 invoice)	110, ⁰⁰
Ink cartridge, print pre-symposium field trip guide (1 invoice)*	49, ³⁰
Air mail (1 invoice)	23, ²⁰
Communication costs (telephone and internet)	9, ⁵⁰
Subtotal Organizational Expenses	USD 292,⁰⁰
Enter GRAND Total of Above	USD 5000,⁰⁰.-

*Exchange rates: 1 USD=\$U 23.80

7.2. Additional funding obtained

Estimated total expenses from all sources, including IGCP-funds (delegate's contributions, organizing institutions, sponsors, sponsoring research projects): **US\$ 55.000.**

Significative amounts of funding (US\$ 15.500) were provided to V SSAGI by sponsors, such as PETROBRAS (Brazilian Oil Company), ThermoFinnigan, Guaraní Aquifer Project, CSIC (Uruguayan Science Commission) and ALGU (Uruguayan Geologists Association).

Other funds came from the participants (registration fees, field trip fees), which in some cases financed their expenses through research projects in their home countries. A significant contribution was made by the Facultad de Ciencias (Montevideo), INSUGEO (Tucumán) and Universidad Nacional de La Plata (4 x 4 vehicles, infrastructure, support personnel).

Less than one tenth of total expenditures were actually financed with funds provided by IGCP 478.

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8. Attach any information you may consider relevant

Attached documents

The following documents will be sent to IGCP Secretariat through UNESCO Regional Office Montevideo:

- (a) One short papers volume of the V. South American Symposium on Isotope Geology

- (b) One volume of Abstracts with Programme of the V. South American Symposium on Isotope Geology
- (c) Field trip guide: Poiré, D.G. & Gaucher, C. 2006. Neoproterozoic/Lower Palaeozoic sedimentary successions of the Río de la Plata Craton, Field trip guide. V South American Symposium on Isotope Geology, Punta del Este, pp. 1-54.
- (d) Field trip guide: Aceñolaza, G.F. 2006. The Puncoviscana Formation of NW Argentina: a review. V South American Symposium on Isotope Geology, Punta del Este, pp. 1-15.