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Sial, Alcides N.; Ferreira, Valdez P.

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stone with dropstone on the roche moutonnée from Salto, to cross-bedded and “convoluted” sandstone beds in the river channel, toward NW. They are interpreted as proximal and distal glacial facies respectively, associated with an advance and retreat of the glacier.

Those rocks are overlain by an extensive and thick shale (pellitic) section that may represent the deposit of a marine transgressive post-glacial episode. Dropstones in the shale denote presence of icebergs and permanence of glacial influence during sedimentation. — (*December 14, 2001*) .

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**E-mail: jbviviani@aol.com

MULTIDISCIPLINARY THEMES

ALCIDES N. SIAL AND VALDEREZ P. FERREIRA
(ORGANIZERS)

EFFICIENT ALGORITHMS FOR PACKING BOXES INTO CONTAINER

SOSTENES L. S. LINS

Departamento de Matemática, CCEN, Universidade Federal de Pernambuco, Recife, PE, Brazil.

The problem of packing boxes into bigger boxes (containers) is a practical problem which, by its economical significance, deserves a serious and inspired scientific approach. From a strictly mathematical point of view, it is an incredibly challenging problem which badly needs good heuristics to solve it. We have been involved in trying to find such heuristics since 1997. These heuristics use new concepts in graph theory (the tets), in data structure (the phormas), and used some classical algorithms as topological sorting and the coding of combinatorial objects to approach real world packing problems. A distinguished feature of our approach is the visual treatment of the spatial packing: we produce a sequence of homogeneous increments (a loading plan) in the packings which makes it easy to visualize and to actually produce the solutions found.

We have produced a set of effective heuristics for dealing with real world box packing problems: we permit various types of boxes, various types of containers, demand requirements on the boxes and the information on which box types can change its vertical direction. The implementation of our heuristics produces very good packings as compared with non-scientific ones: typically we

put 7% to 12% more boxes. The full paper related to these matters is scheduled to be published this year (2002) in the European Journal of Operations Research.

A computer package named ExpedPlex is under development, where the pertinent algorithms are being efficiently implemented. — (*May 24, 2002*) .

MAGNETOMETRY USING SQUID

FERNANDO L. A. MACHADO

Departamento de Física, UFPE, Cidade Universitária, 50670-901 Recife, PE.

Presented by ANTONIO CID B. DEARAÚJO

Superconducting Quantum Interference Device (SQUID) is by far the most sensitive device ever built. It is a magnetic flux detector that can be used to measure magnetic field as low as few femtoTesla. Because of its high sensitivity, SQUID are being employed in detecting magnetic field generated by neural brain activity, noninvasive detection of metallic pieces inside the human body, nondestructive evaluation of corrosion and flaws, and in characterizing magnetic properties of materials, just to list few applications. Perhaps, the main limitation to replace most of the available magnetic sensors with SQUID's is the need of using liquid helium to operate them. However, with the recent progress made in the high temperature superconductor research field, there are SQUID being built that operate with liquid nitrogen and this makes them even more attractive.

Nowadays, there is a couple of companies around the world which sales SQUID magnetometers. However, they are too dedicated with almost no flexibility, the price is still too high and it is quite difficult to get maintenance when they fail. Another drawback is that these systems are true black boxes, not allowing graduate students and technicians to be trained in this very important technology. In my talk, I will describe a homemade magnetometer that uses a SQUID as the sensing element to investigate magnetic properties of materials. Our SQUID system operates from room temperature down to 1.5 K in a superconducting solenoid that generates magnetic field as high as 8 T. The SQUID system is particularly important when only a small amount of the magnetic material is available or to investigate system that presents weak magnetism. Some results of the magnetic studies made in magnetic polymers, thin-films and manganites will also be presented. — (*May 24, 2002*) .

HOMOPHONIC SUBSTITUTION

VALDEMAR C. ROCHA JR.

Departamento de Eletrônica e Sistemas, UFPE, Recife, PE, Brazil.

Presented by CID B. DE ARAÚJO

Historically most of the secret-key cryptographic systems that have been broken were broken by exploiting the deviation of the statistics of the clear-text from that of a completely random sequence. *Homophonic substitution* is a venerable technique for converting a clear-text sequence into a random sequence. In 1988 Günther introduced an important generalization of homophonic substitution called *variable-length homophonic substitution*.

The purpose of this presentation is first to review the information-theoretic treatment of Günther's homophonic substitution and then show how to implement it with a finite memory, considering clear-text symbol probabilities which are rational numbers. Shannon's concept of a *strongly-ideal* cipher system will be reviewed in order to provide the motivation for using any kind of homophonic substitution. The precise definition of variable-length homophonic substitution is presented together with the necessary and sufficient condition for such a substitution to be perfect, i.e., to create a completely random sequence. By employing binary coding, perfect homophonic substitution can be achieved with the introduction of less than 2 bits of entropy in each encoded source letter, and can be implemented using less than 4 random bits per coded letter. Some properties of the geometric series, resulting from the base 2 expansion of the clear-text symbol probabilities, are presented and are used to establish an accurate lower bound for the redundancy in homophonic substitution. — (May 24, 2002).

POLYANILINE-SILICON HETEROJUNCTIONS AS A SENSING DEVICE

WALTER M. AZEVEDO

Departamento de Química Fundamental, CCEN, Universidade Federal de Pernambuco, Cidade Universitária, 50670-901 Recife, PE, Brazil.

Presented by GILBERTO F. DE SÁ

Increasing concern with environmental and personal protection together with widespread requirements for more accurate process control has created a need for new or improved sensors for measuring both physical and chemical parameters. This need for better sensors is strongly influenced by the increasing use of intelligent

microelectronics for monitoring and control.

Among several sensing devices developed for a wide range of gases, from organic or inorganic pollutants which must be measured at parts per millions level or lower, the conducting polymer or more specifically polyaniline have been considered as a prominent new materials for the development of chemical sensors. The very great interest for these polymers is the relative ease of syntheses by chemical or electrochemical oxidative polymerizations of the monomers, and by the fact that the π -conjugated polymer behaves as a synthetic metal when simultaneously is in the doped and oxidized state. The combination of these two doping processes allows one to develop a material with interesting electronic, electrochemical, magnetic or optical properties.

In the last decade our group has been concentrated with the development of new synthetic routes to prepare conducting polymer to improve its solubility and processability, also we have been involved with the development of sensor for glucose (1-2), ammonia (3), salinity measurements (4), radiation detection (5) using polyaniline as a active support. In this meeting we will present the recent development of semiconductor-polymer heterojunction to be applied as a gamma radiation detection and as a gas-sensing device. — (May 24, 2002).

NATURAL RADIOACTIVITY: OCCURRENCE AND APPLICATIONS ON ENVIRONMENTAL STUDIES

JOSÉ M. GODOY

IRD/CNEN/MCT and PUC-Rio, Rio de Janeiro, RJ, Brazil.

Presented by GILBERTO F. DE SÁ

Although the radioactivity concept has been intrinsically bounded to its weapon applications or to nuclear disasters, as that of Chernobyl, we should not forget that radioactivity is a natural phenomenon and there are radioactive substances in the air we breathe, in the food we eat and even in our clothes.

Natural radionuclides cover a large variety of chemical elements that allows several applications on environmental studies. One of the most known is dating, not only with ^{14}C but, also, with other radionuclides. The so-called radioactive disequilibrium of the uranium and the thorium series could be applied on the study of geochemical processes as water mixing, residence times and siltation rates.

The present talk aims, initially, to refresh the concept of radioactivity as natural phenomena, including natural

radionuclides origin and abundance on different environmental matrices. Following, potential applications on environmental studies will be presented, and, finally, results obtained on several project developed by the Instituto de Radioproteção e Dosimetria/Comissão Nacional de Energia Nuclear (IRD/CNEN/MCT) and by the Chemistry Department of PUC-Rio. — (May 24, 2002).

CLINICAL STUDIES – GENERIC MEDICINES

ANTONIO J. ALVES

LTQF – Bioequivalence Center, Pharmaceutical Sciences Department, UFPE, Cidade Universitária, Recife, PE, Brazil.

Presented by HELIO B. COUTINHO

Clinical testing is not the only way to discover drug effects on people. That is the reason controlled clinical trials are the only legal basis for central regulatory agencies in each country, such as FDA, to conclude that a new drug has clinical effectiveness for a drug or biologic. Before clinical testing begins, researchers analyze the drug's main physical and chemical properties in the laboratory and study its pharmacological and toxic effects in laboratory animals. On the other hand, bioequivalence studies are the clinical test used, most often, when a sponsor proposes manufacture a generic version of an approved off-patent product. The law 9.787 (1999), established the legal basis for the institution of generic drugs in Brazil. Our research group started clinical trial and bioequivalence studies, with collaboration of the Public Pharmaceutical Laboratory of Pernambuco State (LAFEPE), the Brazilian official company to pioneer the development of medicines for AIDS and herpesviruses treatment, between 1995 to 1998, even before the establishment of generic policy in Brazil. In 1997 and 1998, LAFEPE was ranked in 21st market position vs. all public and private pharmaceutical laboratories in Brazil. The Aids medicines at a low cost increased the production and sales, and were the main reason of such inedited result.

As a result of the studies developed, the following medicines were introduced to the Brazilian market by LAFEPE: stavudine and zidovudine (AZT) capsules, ganciclovir injectable, lamivudine + AZT, didanosine, lamivudine, and zalcitabine tablets. The result showed bioequivalence for lamivudine tablets (RT) as the 90% CI for both Cmax (99,7) and AUC0-12 (96,7) geom. mean ratios lie within the 80-125% interval. On AZT + DDI therapy the plasma HIV RNA levels decreased > 0,5 log after 30 days. The ganciclovir

clinical study showed similar results in reference product by the control of retinitis in Aids patients infected with CMV. The stavudine and zalcitabine clinical study demonstrated no adverse effects reported and biochemical parameters remained unchanged and within the reference range. The pharmacokinetics parameters found for AZT + Lamivudine tablet were: AUC0-12 (8975 e 12.189ng.h/ml); Cmax (7.330 e 3.610 ng/ml) respectively, similar to the reference medicine. — (May 24, 2002).

* E-mail: leac@nlink.com.br

BACTERIOLOGICAL LARVICIDES OF DIPTERAN DISEASE VECTORS

MARIA HELENA N. L. SILVA-FILHA

Centro de Pesquisas Aggeu Magalhães – FIOCRUZ, 50670-420 Recife, PE.

Presented by HELIO B. COUTINHO

The bacteria *Bacillus sphaericus* (*Bs*) and *B. thuringiensis* serovar. *israelensis* (*Bti*), display toxic action on mosquitoes and black flies, important vectors of man disease, acting as per os larvicides. These sporulating bacteria show a major advantage over synthetic insecticides: selectivity due to the specific mode of action. *Bs* is toxic against some species of Culicidae while *Bti* is also highly toxic against Simuliidae.

Both bacteria produce, during the sporulation, crystals, which contain protoxins. *Bti* crystals contain four polypeptides of 123-, 135-, 72- and 28-kDa, respectively called Cry4A, Cry4B, Cry11A and CytA. For *Bs*, crystals contain a toxin (Bin) made of two polypeptides of 42- and 51-kDa, called BinA and BinB, respectively. The mode of action of these proteins on larvae involves the ingestion of crystals and spores in suspension in water. Inside the midgut lumen, under the action of the alkaline pH and proteinases, protoxins in the crystals are solubilized and activated. Released toxins bind to apical microvilli of midgut cells, then cytopathological alterations are observed in midgut cells, leading to the death of larvae. Those toxins need to act in synergy to display the full toxicity and also bind to specific receptors in the larval midgut. Recently, the receptor of the Bin toxin of *Bs* in *C. pipiens* larvae was identified as being an α -glucosidase of 60 kDa.

Bti and *Bs* based larvicides have been produced and successfully used in vector control programs throughout the world. *Bti* has been mostly used to control species

of *Simulium* and *Aedes*, vectors of onchocerciasis and dengue, respectively, while, *Bs* is very effective for controlling *Culex* species, vectors of filariasis and encephalitis. Data from the operational use of microbial larvicides in several countries, in the past two decades, have confirmed the effectiveness of *Bti* and *Bs* and their safety to non-target species. On the other hand, *Culex* populations intensively sprayed with *Bs*, can display resistance. Data shows that *Bs* should be used into integrated programs with other control agents such as *Bti*, in order to avoid these phenomena. Resistance is unlikely to appear towards *Bti* due to its multiple toxins. — (May 24, 2002).

* E-mail: mhneves@cpqam.fiocruz.br

X-RAY DIFFRACTOMETRY APPLIED TO THE COMPARATIVE STUDY OF PROCESSES OF FORMATION OF AUTOMOTIVE BATTERIES

LUCILA E. P. BORGES

Departamento de Engenharia de Minas, CTG-UFPE, Recife, PE, Brazil.

Presented by VALDEREZ P. FERREIRA

X ray diffraction was applied to the investigation of the main steps in lead acid battery production (mixing, soaking and formation) in order to improve manufacturing conditions and to contribute with a theoretical understanding of these processes.

In the first step, mixing, the following results were obtained: (a) liquid nitrogen freezing of the paste was effective; (b) the reaction was instantaneous; (c) it is directly related to the amount of acid added.

In the soaking step, plates with a high content of total sulfate display a final monobasic lead sulfate content bigger than those displayed by plates with low content of total sulfate. In order to explain this behavior, two hypotheses are proposed: (a) 3BS could lead to monobasic sulfate crystallization; and (b) 1BS initially present in the plates could act as seeds for further crystallization. Crystal sizes were also followed as a function of time during the soaking period, demonstrating the possibility of extending the use of X-ray diffraction in the observation of crystal sizes in this and any other step of battery production.

In continuous current formation it was observed that higher temperatures (60°C) are favorable, affected by an increase in current and especially by the interaction: increase in current vs. increase in density. The best results of plate formation were obtained with plates rich in triba-

sic lead sulfate. It was found that the total charge used in the industry is too high and a reduction of up to 43% of the charge yields excellent results, with PbO₂ contents as high as 92% with an average of 80%.

A laboratory test of pulsed formation showed that longer time is the main factor in order to achieve better results, moreover longer pulses in experiments with short times also yield higher contents of PbO₂.

In a comparison of both formation schemes it was observed that pulsed formation was more efficient, with respect to total PbO₂ obtained, with plates richer in tetrabasic sulfate. In continuous formation, under the same experimental conditions, no tetrabasic sulfate remains unformed. — (May 24, 2002).

OXYGEN ISOTOPES INTERNAL EQUILIBRIUM IN MAGMATIC EPIDOTE-BEARING GRANITOIDS

VALDEREZ P. FERREIRA¹, JOHN W. VALLEY²,
ALCIDES N. SIAL¹ AND MICHAEL J. SPICUZZA²

¹NEG-LABISE, Department of Geology, UFPE, Cx. Postal 7852, 50732-970 Recife, PE, Brazil.

²Department of Geology and Geophysics, University of Wisconsin, 1215 W. Dayton St., Madison, WI, 53706, USA.

In this study we present oxygen isotope compositions of mineral separates from three metaluminous epidote-bearing granitoid series from northeastern Brazil.

Zircon has an overall $\delta^{18}\text{O}$ variation of $\sim 5\text{‰}$, ranging from 5.72‰ to 10.30‰, but is very homogeneous within a single pluton. The highest values of $\delta^{18}\text{O}$ (zircon) ($9.88\text{‰} \pm 0.35\text{‰}$; $n = 13$ samples) are for the calc alkalic granitoids, which are slightly, but significantly higher than those for high-K calc-alkalic granitoids ($9.10\text{‰} \pm 0.41\text{‰}$; $n = 19$ samples) with little overlap. Values for these granitoids greatly differ from the average for the shoshonitic granitoids ($7.43\text{‰} \pm 0.19\text{‰}$; $n = 5$ samples), and from that for the São Rafael pluton, a high-K calc-alkalic granitoid ($5.92\text{‰} \pm 0.26\text{‰}$; $n = 9$ samples). These differences repeat for the other analyzed minerals, with little overlap of values. There is a good positive correlation between mineral pairs in the three series, although quartz-epidote and zircon-epidote fractionations are higher than predicted for equilibrium at magmatic temperatures. Measured mineral-mineral fractionations suggest continuous sub-solidus inter-mineral isotope exchange among all minerals except zircon. Calculated $\delta^{18}\text{O}$ (magma) values using whole rock SiO₂ contents and $\delta^{18}\text{O}$ (zircon) values are up to 1‰ lower than those

calculated using $\delta^{18}\text{O}$ (quartz); values of $\delta^{18}\text{O}$ in zircon are interpreted to provide the best evidence of magmatic value. Oxygen isotope fractionation between natural zircon and magmatic epidote is opposite to that predicted from theoretical determinations, as in all analyzed samples $\delta^{18}\text{O}$ (epidote) < $\delta^{18}\text{O}$ (zircon). The systematic mineral-epidote fractionations suggest that epidote cooled in a closed system, and is magmatic in origin. — (May 24, 2002).

CHROMITITES ASSOCIATED WITH LAYERED COMPLEXES IN BRAZIL: TESTING "ONE-FIT-ALL" GENETIC MODELS

CESAR F. FERREIRA-FILHO

Instituto de Geociências, UnB, 70910-970 Brasília, DF, Brazil.

Presented by ALCIDES N. SIAL

Chromitites represent a special case of cumulate rock where chromite is the only cumulus phase. Formation of chromitites thus requires that phase relations of the appropriate system are somehow changed to allow the system to fall into the chromite stability field. Several "one-fit-all" models were proposed to explain the origin of chromitite layers.

Mineral chemistry data were collected for three layered intrusions in Brazil; Bacuri Complex (Amapá), Ipueira-Medrado Sill (Bahia) and Niquelândia Complex (Goiás). They have distinct igneous stratigraphy, thus providing opportunity to look at chromitites formed in different environments.

At the Bacuri Complex, most of the chromite is concentrated in a single few meters-thick chromitite layer located at the base of the Ultramafic Zone (UZ) in direct contact with the underlying Lower Mafic Zone. Cryptic variation data is consistent with extensive fractionation within the UZ. The stratigraphic position of the main chromitite strongly supports a model for its origin associated with a major new influx of primitive magma, and mixing with more fractionated resident magma.

At the Niquelândia Complex, chromitites consist of several few centimeters-thick layers restricted to a 20 meters-thick horizon within an estimated 3 km-thick Ultramafic Zone. Detailed cryptic variation data indicate that the 20 meters-thick interval marks a slight reversal of the fractionation path. The data support a model for its origin associated with new influx of primitive magma, and mixing with slightly more fractionated resident magma.

At the Ipueira-Medrado Sill, a 5-8 meters-thick

massive chromitite layer (MCL) is hosted by a 200-300 meters-thick layered intrusion. The MCL is located at the transition from dynamic open system to mainly closed system magma chamber. The most primitive compositions are observed at the MCL. Cryptic variations are the opposite to what is expected as the result of a new influx of primitive magma. Re-Os and Sm-Nd data indicate strong crustal contamination suggesting that chromite crystallization was triggered by changes of physical conditions associated to crustal contamination.

The data indicate that the chromitite layers are always associated with major changes in the magmatic chamber. However, a single genetic model does not apply to the three examples investigated. — (May 24, 2002).

* E-mail: cesarf@unb.br

FAST ENVIRONMENTAL IMPACT ASSESSMENT THROUGH ICP-MS: APPLICATION TO BIVALVES FROM A TROPICAL ESTUARY (PINA BAY, RECIFE, BRAZIL)

EDMILSON S. LIMA¹, MONICA F. COSTA², AGUSTIN PASTOR³ AND MIGUEL DE-LA-GUARDIA³

¹Geology Department.

²Oceanography Department, Federal University of Pernambuco, 50730-540 Recife, PE, Brazil.

³Department of Analytical Chemistry, University of Valencia, 50 Dr. Moliner St, 46100, Burjasot, Valencia, Spain.

Presented by ALCIDES N. SIAL

The use of the semi-quantitative analysis in environmental impact assessment studies was evaluated through a comparative study using quantitative and semi-quantitative operational modes in ICP-MS. Twenty one elements, namely, ⁷Li, ¹¹B, ²⁷Al, ⁴⁸Ti, ⁵¹V, ⁵²Cr, ⁵⁵Mn, ⁵⁸Ni, ⁵⁹Co, ⁶³Cu, ⁶⁴Zn, ⁶⁹Ga, ⁸⁸Sr, ⁹⁰Zr, ⁹³Nb, ⁹⁸Mo, ¹¹⁴Cd, ¹⁸¹Ta, ¹³⁷Ba, ²⁰⁵Tl and ²⁰⁸Pb were analyzed in both methods. Sample digestion was performed in closed microwave Teflon vessel using nitric acid and hydrogen peroxide. The semi-quantitative analyses were performed using Rh as an internal standard and a solution containing Be, Ge, In and Re was used to calibrate the instrument. Accuracy studies for CRM samples, using the semi-quantitative mode analyses, evidenced that all the elements considered were within the certified range except for Cu and Pb that gave higher values than both certified values and quantitative mode analysis. In order to verify the applicability of the semi-quantitative method to

environmental assessment studies, mollusk samples from a tropical estuary (Pina Bay, Pernambuco, Brazil) were analyzed. The results show that some species concentrate some element relative to others, probably as a consequence of each species feeding habit. Even though there is no specific legislation regarding metal concentration in seafood in Brazil, the results show that metal concentrations do not exceed international limits, except for V, which exceeded the EPA risk level. Pina Bay is highly impacted by sewage discharges but the metal concentration in the mollusk populations do not seem to cause a threat to human consumption. The results also suggest that the semi-quantitative method could be used as a screening method in environmental impact assessment studies. — (May 24, 2002) .

TECTONIC EVOLUTION OF THE ASUNCIÓN RIFT, EASTERN PARAGUAY

CLAUDIO RICCOMINI, VICTOR F. VELÁZQUEZ,
CELSO B. GOMES, ANDERSON MILAN AND
ALETHÉA E. M. SALLUN

Instituto de Geociências, Universidade de São Paulo, 05508-900 São Paulo, SP, Brazil.

The Asunción Rift is an important tectonic feature of Mesozoic-Cenozoic age in eastern Paraguay. With a width between 25 and 40 km, this structure consists of three segments: the well-defined western segment with a NW-SE strike and extending over 90 km between Benjamin Aceval and Paraguarí; the central E-W segment of about 70 km in extent linking the cities of Paraguarí and Villarrica; and the less-defined eastern segment, 40 km-long, with a NW-SE strike, between Villarrica and the Cordillera del Ybytyruzú.

Tectonic studies in the region revealed a first phase of faulting during the Early Cretaceous associated with tholeiitic magmatism in the eastern segment of the rift and followed by expressive alkaline (potassic) magmatism mainly in the central segment of the rift. Structural analysis of diabase and alkaline dyke swarms indicated the action of a paleostress field with σ_1 NW-SE oriented /horizontal, σ_2 vertical, and σ_3 NE-SW/horizontal, related with an E-W oriented, right-lateral strike-slip binary.

During the Paleocene, the western segment of the rift was filled by fanglomeratic, aeolian and volcanoclastic deposits of the Patiño Fm. Deep NW-trending lithospheric faults served as conduits for ultra-alkaline rocks, of nephelinitic composition, bearing spinel lherzo-

lite mantle xenoliths. These rocks intruded the still un lithified sediments of the Patiño Fm. causing syndimentary hydrothermal silicification. This fact and the presence of volcanic fragments (bombs and lapilli) indicates that the Patiño Fm. represents the sedimentary record associated with tectonic and magmatic episodes that occurred in the Asunción Rift during the Paleogene. Structural analysis of nephelinitic plugs, necks and dikes indicated a paleostress field with σ_1 NW-SE/horizontal, σ_2 vertical, and σ_3 NE-SW/horizontal, also related with an E-W oriented right-lateral strike-slip binary.

Quaternary faulting, recorded in the western segment of the rift, shows a stress field with σ_3 horizontal along the E-W direction, probably responsible for the installation of the Ypacaraí Graben and the morphological compartmentalization of the region. — (May 24, 2002) .

* E-mail: riccomin@usp.br

AN INTEGRATED IDTIMS, EVTIMS AND SHRIMP ZIRCON DATING STUDY

KEI SATO

Instituto de Geociências, Universidade de São Paulo, 05508-900 São Paulo, SP, Brazil.

Presented by VALDEREZ P. FERREIRA

An integrated IDTIMS (isotope dilution thermal ionization mass spectrometry), EVTIMS (evaporation thermal ionization mass spectrometry) and SHRIMP (Sensitive High Mass Resolution Ion Microprobe) study of Archean orthogneiss reworked in the Brasiliano orogeny is discussed here. The sample comes from the Atuba Complex, near Curitiba, Paraná State.

Zircon age determination by three methods are 3055 ± 90 (IDTIMS upper concordia intercept), 3000 ± 40 Ma (EVTIMS $^{207}\text{Pb}/^{206}\text{Pb}$ plateau) and 3079 ± 23 Ma (SHRIMP). These results are in good agreement.

The SHRIMP analysis guided by cathodoluminescence (CL) also recognized younger age (e.g. ca. 2920 Ma, 2200 Ma and 800 Ma) events in the growth/evolution of the zircons. The petrography of the zircons revealed by the CL images also clearly demonstrated that 3000-3100 Ma zircon population is igneous oscillatory-zoned zircon, and is not an inherited component in a younger rock. Thus it is clear that MJ316 is a Mesoproterozoic rock.

The EVTIMS, "step heating", of one of the studied zircons showed that $^{207}\text{Pb}/^{206}\text{Pb}$ date rises from ca.

2350 Ma at 1370°C to reach a plateau equivalent to ca. 3000 Ma from 1420°C. This in accord with an event at ca. 2200 Ma seen in the SHRIMP data, where there would have been not only development of partial overgrowths but also variable loss of some radiogenic Pb from "damaged" ca. 3000 Ma zircon as well.

The IDTIMS study involved analysis of multigrain unabraded aliquots and also leached grains, now known from CL images to be structural complex. The upper concordia intercept (3055 Ma) can only be considered as an "average", indicating an important component of Mesoproterozoic zircons. Two leaching phases yielded close to concordant dates at ca. 2390 Ma – in agreement with the more interpretable SHRIMP indications of ca. 2200 Ma zircon growth/thermal disturbance.

It is considered that in this complex rock it is fortuitous that IDTIMS, EVTIMS and SHRIMP results give essentially the same protholith ages. In the other cases in the literature where there have been comparative EVTIMS/IDTIMS – SHRIMP studies of geologically complex samples with structurally complex zircons, dates by the methods do not always agree. However, when geologically simple samples are dated by the different methods the results are generally in good agreement. — (May 24, 2002) .

* E-mail: keisato@usp.br

C-ISOTOPE COMPOSITION OF EARLY PALEOPROTEROZOIC CARBONATES FROM THE MINAS SUPERGROUP AND THE RECORD OF THE LOMAGUNDI PHENOMENON IN BRAZIL

ALCIDES N. SIAL¹, VALDEREZ P. FERREIRA¹ AND ANTONIO W. ROMANO²

¹NEG-LABISE, Department of Geology, UFPE, Cx. Postal 7852, 59732-970 Recife, PE, Brazil.

²Institute of Geosciences, UFMG, 30430-120 Belo Horizonte, MG, Brazil.

The Paleoproterozoic $\delta^{13}\text{C}_{\text{carb}}$ positive excursion (2.25–2.05 Ga; Lomagundi phenomenon) has a global character, but no occurrence in South America has been registered. This study reports, by the first time, this C isotope anomaly in Brazil, in the early Paleoproterozoic, marine carbonates of the Fecho do Funil Fm., Minas Supergroup.

The 2.42 Ga-old Gandarela Fm. consists of red carbonate BIF at the base of the sequence (Minas Super-

group), gradually replaced upwards by buff dolomites, and limestones, locally stromatolitic, in light and dark-gray alternating bands. Carbonates display $\delta^{13}\text{C}_{\text{carb}}$ from -1.6 to $+0.4\text{‰PDB}$ ($n=58$), the most negative values found in red dolomites in contact with the underlying, finely laminated, Cauê banded iron formations. Gandarela carbonates from the Hargraves quarry yielded $\delta^{13}\text{C}_{\text{carb}}$ from -1.4 to -0.6‰PDB ($n=28$). In the Cercadinho Fm., at the base of the Piracicaba Group, $\delta^{13}\text{C}_{\text{carb}}$ varies from $+3.3$ to $+4.2\text{‰PDB}$ ($n=10$), values decreasing erratically with depth.

The Fecho do Funil dolomites (2.11 ± 0.11 Ga, deformation/metamorphic age) were probably deposited within the time span for the Lomagundi positive excursion age of the Kaapval craton, Africa. The sampled section of this Formation consists, at the base, by fine-grained, stromatolite-rich white and pink dolostones, and then by fine-grained white marble. Stratigraphically collected samples show $\delta^{13}\text{C}_{\text{carb}}$ remarkably homogeneous ($+6.0$ to $+6.5\text{‰PDB}$, $n=47$). The oxygen isotopes are also fairly constant (-9.7 to -10.8‰PDB) and show a trend which is rather antipathetic to the variation in C isotopes. These high $\delta^{13}\text{C}_{\text{carb}}$ carbonates show little scatter, relatively shallow trend on $\delta^{13}\text{C}$ vs $\delta^{18}\text{O}$ diagram and are consistent with low-grade metamorphic decarbonation. The elevated C-isotope values were least reset and probably reflect their protolith composition, rather than subsequent diagenetic or metamorphic processes. This Formation is a proxy, in South America, for the global Lomagundi phenomenon.

There is no evidence for the triad early Paleoproterozoic glacial events of the (2.45 – 2.25 Ga interval) recognized in North America. C isotope patterns for carbonates of the Minas Supergroup suggest that the Gandarela Fm. was deposited around 2.4 Ga; the moderate C positive anomaly of the Cercadinho carbonates suggests deposition around 2.35 and the Fecho do Funil carbonates were deposited probably around 2.2 Ga. — (May 24, 2002) .

A NEW INTERPRETATION ON THE SERGIPANO BELT DOMAIN

MARINHO A. SILVA-FILHO AND HELTON H. F. TORRES

Companhia de Pesquisa de Recursos Minerais (CPRM), Recife, PE, Brazil.

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This study deals with newly identified tectonic-

stratigraphic domains in the Sergipano and Sul-Alagoano belts of the Borborema Province, northeastern Brazil. In the first belt, besides the well-known domains of Macururé, Vaza Barris and Estância, two others are recognized: Rio Coruripe and Viçosa. The Rio Coruripe domain contains rift-related volcano-sedimentary sequence, metabasalts and iron-formation bearing, intruded by mafic-ultramafic layered complex. The Viçosa domain consists of a metamorphosed volcano-sedimentary sequence; Mesoproterozoic plutonic rocks with 1.57 Ga (U-Pb) and 1.0 Ga (Rb-Sr) and Neoproterozoic peraluminous granitoids with 0.75 Ga (Rb-Sr) and calc-alkaline granites with 0.59 Ga (U-Pb). Carbonates from the Olhos d'Água Fm. of the Vaza Barris domain have an isotopic signature similar to that of the Bambuí group, distinct of the Jacoca carbonates (Miaba group). The Palestina Fm., at the base of the Olhos d'Água Fm., encloses Miaba group deformed pebbles. The last one, chronocorrelated to the Macururé group, is Mesoproterozoic in age. The Sul-Alagoano belt has two domains. The Canindé-Marancó domain hosts flysch-type volcanoclastic sedimentation; calc-alkaline volcanic rocks with 1.04 Ga (U-Pb; TDM=1.2 Ga); tonalitic (TDM=1.75 Ga) and peraluminous (TDM=1.66 Ga) Mesoproterozoic plutonic rocks; early peraluminous Neoproterozoic plutonic rocks (U-Pb; 0.715 Ga); podiform chromite-bearing ultrabasic rocks that could be mantle-derived ophiolitic slices. The Pernambuco-Alagoas domain shows a characteristic tonalitic-dominant Mesoproterozoic plutonism (TDM=1.3 Ga); fracture-bound late shoshonitic/peralkaline and peraluminous magmatism (0.58 Ga, Rb-Sr and TDM=1.0 Ga).

The Sergipano belt has rift-related and Atlantic margin Meso/Neoproterozoic platform sedimentation. Basement nucleus (TDM=3.0 Ga), granitoids from the Macururé domain with model ages between 1.71 and 1.3 Ga and from Viçosa domain between 0.9 and 2.5 Ga, suggest a sialic basement. The Marancó/Canindé calc-alkaline volcanics and ophiolites (?) point to the presence of oceanic crust in the Sul-Alagoano belt. Abundant Mesoproterozoic tonalites resemble a thickened Andean-type arc in the Pernambuco/Alagoas domain, with extensional shoshonitic/peralkaline magmatism (0.58 Ga, Rb-Sr). There were two stages of amalgamation in the Sergipano and Sul-Alagoano belts: at 1.0 and at 0.75 Ga, characterized, respectively, by Caririano- and Brasiliano age peraluminous granitoids. The sutures between belts and their domains are bounded, respectively, by the Belo

Monte/Jeremoabo shear zone and granites, both showing remarkable magnetic anomalies. — (May 24, 2002).

HYDRODYNAMICS OF THE AMAZON BASIN

PIERRE SABATÉ

Institut de Recherche et Développement (IRD), Brasília, DF.

Registered under the CNPq/IRD convention, the HYBAM project is a model of multi-institutional and international cooperation. It involves the ANA, ANEEL and UnB, as well as researchers from other Brazilian (USP-CENA, UFRJ, IBGE, IEPA) Institutions and some neighboring countries (Bolivia, Peru and Equator).

We show here the wide spectrum of collected data on the Amazon River and its affluents, from Tabatinga to the Atlantic Ocean and an extensive view on modelling and applied domains. Complementary approaches are developed to understand hydrologic dynamics related to climatic forcing, sedimentary and geochemical dynamics.

The methodology implements a hydrologic permanent station net. The studies cover an altimetric calibration of the whole hydrologic network, rivers discharge gorges and several parameters to quantify dynamic processes. They encompass the wave tide influence on liquid and sedimentary discharge of the Amazon River and the influence of climatic index on its respective variability. The role played by flood plains on hydrodynamics is studied and inundation dynamics is followed by satellite imagery. Balance between erosion, transfer and depositional processes, from Andean sources to flood plains, is estimated by flux method and the present sedimentation, by geochemical tracers and geochronologic models. Space and time variability of trace element signatures of surface waters is studied to evidence trap areas and speciation risks of some heavy metals related to a historic study of mercury contamination.

One of the scopes is the Amazon river hydrology modeling (climate versus river discharge relation), its hydrodynamics applied to the prediction of water levels, flow velocities and flood plain dynamics, and of its sedimentology (transport capacities and sediment trapping quantification). Modeling will be useful to investigate the impact of anthropic activities (dams, mining, and so on) improve management of water resources, predict floods (cities of Manaus or Santarém) as well as navigability conditions (Madeira River). The research teams are preparing the corresponding GIS-Amazônia for these studies. — (May 24, 2002).