MATHEMATICAL, PHYSICAL, AND ENGINEERING SCIENCES

1. THE GENUS *Pandanus:* ITS CHEMISTRY AND BIOLOGICAL POTENTIAL

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About 52 *Pandanus* species, some of which are indigenous, were reportedly found in the Philippines. Little chemical work has been done on this botanically complex genus. Piperidine type alkaloids, namely pandamarine, pandamarilactone-1, -31, -32 were isolated from the leaves of *P. amaryllifolius.*

Several *Pandanus* species from Manila, Isabela, Laguna, the Bicol provinces are currently being worked on either for their alkaloids and/or their biologically active compounds. The *Pandanus* crude extracts were tested for their antimicrobiological activities, toxicity, antituberculosis activity, and diuretic property.

With the evident confusion in the botanical classification of some species of the genus *Pandanus,* it is hoped that the study of its chemical components may facilitate taxonomic reevaluation of these documented species. This paper will present the findings on the chemical constituents of selected *Pandanus* species and their biological potentials.

2. EFFECT OF CROSS-LINKING TEMPERATURE ON THE LIQUID-CRYSTALLINITY OF SIDE-CHAIN POLYMERS

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The effect of cross-linking temperature on the thermal stability of the nematic side-chain epoxy polymer 1 and the smectic siloxane copolymer 2 was investigated by thermal analysis using Differential Scanning Calorimetry. Cross-linking of 1 was carried out by reacting ethyleneglycol diglycidyl ether with the mesogenic amine 4-(ω-aminoheptyloxy)-4'-cyanobiphenyl in the presence of 1,10-diaminodecane as cross-linking reagent at a temperature above the clearing point of polymer 1. Liquid crystallinity was observed with the concentration of the cross-linking agent up to 5 mol%. Further increase of the network density resulted in loss of the nematic order.

Cross-linking of thin films of 2 was achieved by photo-irradiation at temperatures below and above its clearing point. Photo-crosslinking at the mesomorphic state was found to stabilize the smectic order. However, irradiation performed at the isotropic phase gave no significant change in the clearing point of the copolymer.

These observations suggest that the state of order during the cross-linking reaction and hence the cross-linking temperature influences the phase transition of the final network.

3. ON THE POWER OF OPERATORS OF HIGHER ORDER IN STRUCTURAL COMPLEXITY THEORY

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We shall investigate the newly introduced operators of higher order and show that they are quite powerful. In particular, we shall show that $\exists^1$co-RP =IP and $\exists^2$co-RP =MIP where IP is the class of languages accepted by interactive proof systems and MIP is the class of languages accepted by multiprover interactive proof systems.

4. LATIN SQUARE COMPOSITION OF FINITE LAGRANGIAN QUASIGROUPS AND GROUPS

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The Cayley table (or structure matrix) of any finite quasigroup such as a loop a pseudogroup, or group is a **Latin square** and conversely every Latin square defines a finite quasigroup. Moreover, if the quasigroup is **Lagrangian** (or has a unique coset decomposition), then its Cayley table has a characteristic block form such that each block is a Latin square (also called a Latin coset block) whose entries are elements of a single coset.

This paper shows that any finite Lagrangian quasigroup has a **characteristic coset block composition** such that each block is a Latin square that can be derived from the basic Latin square block in reduced form called the **cyclic block** by means of **three elementary block operations**: (1) interchange of rows, (2) interchange of columns, and (3) renaming of elements. Two Latin blocks of the same dimensions are said to be **equivalent** if they can be obtained from each other by any or all of these three elementary operations. Hence, any Lagrangian quasigroup can be decomposed into equivalent coset blocks.

The coset block composition of finite Lagrangian systems has been found to be useful in the analysis and construction of loops, pseudogroups, groups, and related structures.

5. AN FET BIOSENSOR FOR NEUTRAL LIPIDS*

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Biosensors present a novel and powerful technique for the measurement of complex molecules. These methods combine a highly specific biochemical system with a highly sensitive electronic system. Biosensor technology offers simple, rapid, and sensitive methods for chemical analysis.

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*Best poster paper award in the Mathematical, Physical, and Engineering Sciences Division.

A biosensor for neutral lipids has been developed by combining an enzyme, lipase, with a pH-sensitive field-effect transistor (FET), a semiconductor device which regulates current through an electric field. The measurement was based on the detection of the pH change accompanying the lipase-catalyzed hydrolysis of triglycerides into glycerol and fatty acids. The enzyme lipase was immobilized on the gate surface of an FET by cross-linking with glutaradehyde and bovine serum albumin. Sensor response was reproducible (relative standard deviation = 4.10%) and displayed high linearity (Pearson correlation coefficient = 0.9997) in the concentration range of 5 mM to 300 mM. Response time and magnitude were dependent on the enzyme load, pH and concentration of buffer, and type of buffer used. The developed sensor will be useful in clinical and industrial laboratories.

6. THE CHROMITE DEPOSITS OF THE DINAGAT OPHIOLITE COMPLEX: CONTRIBUTIONS TO CHROMITE GENESIS

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Dinagat Island is mainly underlain by a mafic and ultramafic rock assemblage known as the Dinagat Ophiolite Complex (DOC). The DOC consists of residual harzburgite, cumulate periodotite, massive gabbro, sheeted dikes, and pillow basalts.

Chromite deposits in the island occur as pods, layers, and irregular bodies within the ultramafic suite (residual and cumulate peridotites) of the ophiolite. All the deposits are enclosed within a serpentinized dunite aureole. Several ore textures are observed in the deposits: massive, layered, disseminated, nodular, orbicular, and asymmetrical ore textures. All textures are seen to grade into each other.

Petrography of chromite grains reveals the presence of silicate inclusions. These inclusions are thought to be contemporaneously crystallizing phases with chromite until probable changes in the system favor chromite formation and eventual termination of silicate crystallization. A change in temperature and/or pressure, an increase in SiO_2 or H_2O content, or an increase in oxygen fugacity of the melt are just some of the processes that must have triggered chromite formation. These changes are perceived to result from magma mixing or melt convection. These interpretations are indirectly supported by the stability relations of the silicate inclusions as well as data from mineral chemistry.

Based on structural interpretations, petrography, and mineral chemistry, it seems that chromite deposits formed in small magma pockets/cavities at the base of the main magma chamber and within fractures in the mantle sequence.

7. GEOLOGY OF THE BAGUIO MINERAL DISTRICT – A GEOPHYSICAL PERSPECTIVE

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Reconnaisance ground magnetic and gravity surveys were conducted in the Baguio Mineral District (BMD) to characterize the signature of this known mineralized area in terms of its response to the magnetic and gravity methods. The geology of the BMD is defined in terms of lithology and favorable areas of mineralization based on their magnetic and gravity signatures.

Intrusive bodies are identified based on their magnetic high/gravity high signatures. Sedimentary units, on the other hand, are characterized by broad, low magnetic, and gravity anomalies.

A significant result of this study is in terms of the signature of mineralized areas. An anomalous zone, correlated with mineralization, was identified to be characterized by magnetic lows and gravity highs. This anomalous zone coincides with the sedimentary and igneous rock boundary. This feature acts as a conduit that allows the passage of core-bearing mineralizing fluids. Being a zone of enhanced permeability and with the corresponding alteration zones noted in the field, this zone is host to mineable mineral deposits.

Results from the magnetic and gravity surveys show that the magnetic and gravity methods are effective tools in the recognition of hydrothermally altered rocks on the basis of their geophysical signatures.

8. OPTICAL SENSOR FOR HYDROGEN PEROXIDE BASED ON THE CHEMILUMINESCENCE OF IMMOBILIZED PEROXYOXALATE

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Hydrogen peroxide (H_2O_2) plays a significant role in environmental processes, such as the decomposition of sulfur oxides in acid rain and the photochemical oxidation of dissolved organic matter in the marine environment. It is also a product

of several enzyme-catalyzed reactions of physiological importance. One of the most sensitive methods available for its quantification is based on chemiluminescence (CL) and peroxyoxalate CL is found to be the most efficient among these processes.

An optical sensor for H_2O_2 based on an immobilized CL reagent was developed. The CL reagent which consists of bis-(2, 4, 6-trichlorophenyl) oxalate (TCPO) and perylene as fluorescer was impregnated on a cellulose membrane disc. The amount of H_2O_2 was quantified by measuring the intensity of the light generated from the reaction of CL reagent with H_2O_2. The instrumentation employed in the measurement involved a fabricated CL detection system which included a photodiode as transducer. The sensor responded linearly to H_2O_2 in the range of 2.5×10^{-8} up to 2.5×10^{-4} moles with relatively high reproducibility. It can detect as low as 25 nanomoles and has a response time of less than 10 seconds. The sensor can be integrated with an enzyme system, such as glucose oxidase and cholesterol oxidase, for the detection of glucose and cholesterol, respectively.

9. IMMOBILIZATION OF METAL COMPLEXES ON SILANE-MODIFIED SILICA SURFACES

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Silica surfaces have been modified with N-heterocyclic containing ligands to afford materials that readily complex a variety of metal ions. The silanol moieties of a silica surface are reacted with (3-chloropropyl) trimethoxysilane producing functional surfaces to which ligands are readily attached via the reaction of the -Cl group with a potassium-ligand reagent. Ligands of particular interest include dipyridylamine and pyrazole. These ligand containing silica surfaces are then utilized to immobilize transition metal complexes, including those of Ni(II) and Rh(I). Characterization of the ligand attached silica and the metal-ligand-silica complexes has been accomplished by the use of NMR(^{1}H, ^{13}C, ^{29}Si), DRIFT, and SEM techniques. The properties of these metal-bound silica materials will be compared to those of similar metal-bound cross-linked polystyrene materials.

10. METAL COMPLEXING CAPACITY STUDIES ON HUMIC SUBSTANCES FROM PHILIPPINE SOURCES

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Potentiometric Stripping Analysis (PSA) was used in the determination of metal (Cu, Pb, Cd, and Zn) complexing capacity of humic substances isolated from Philippine sources. The electrochemical cell used was a wall-tube electrode system: 3-mm glassy carbon working electrode, Pt counter electrode, and Ag/AgCl reference electrode.

The optimum electrochemical parameters were pH 6.7 with 0.016 M HOAc-NaOAc buffer, plating time of 60 s; equilibration time of 120 s and deposition potentials of -500 mV, -900 mV, -1100 mV, and-1300 mV vs Ag/Ag/AgCl for Cu, Pb, Cd, and Zn respectively.

The metal complexing capacities (MCC) of Cu, Pb, Cd, and Zn with fulvic and humic acids extracted from two peat soils, one agricultural soil, one marine sediment, and one river sediment were determined.

The absence of a clear trend in the results suggests that the type of metal ion and the nature of the humic material both affect metal-binding capacities.

mcc

11. SULFUR SATURATION AND SULFIDE MINERALIZATION IN THE ACOJE BLOCK, ZAMBALES OPHIOLITE COMPLEX, PHILIPPINES

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The Acoje Block of the Zambales Ophiolite Complex is known for the occurrence of metallurgical chromite, Ni-Cu sulfides, and platinum-group mineral deposits. These mineral deposits occur and are widely distributed within the transition zone of the upper mantle and lower crust sections of this ophiolite block (Abrajano 1989, Orberger 1993, Yumul 1994).

Two schools of thought are proposed on the possible origin of the precious and base metal distributions in the Acoje Block: hydrothermal and magmatic processes. To reassess and understand the origin and mode of occurrence of the mineral deposits in detail, sulfur saturation analysis applied on the different rocks and ore samples from the Acoje Block is employed. This method is utilized in determining the different mantle and crystal processes (e.g., crystal fractionation, sulfide segregation, etc.) that could have affected the occurrence and distribution of the observed mineral deposits.

Petrographic analyses of the residual harzburgite, transition zone dunite, and mafic cumulates identified several minerals such as olivine, orthopyroxene, and clinopyroxene as the dominant assemblages. Serpentinization is very pervasive in the harzburgites and transition zone dunites. The textures are porphyroclastics and equigranular for the ultramafic rocks. The mafic cumulates are mostly adcumulates to mesocumulates. Pentlandite, mackniawite, chalcopyrite, and pyrite are some of the sulfide minerals noted in the transition zone dunite.

Utilizing Barnes et al. (1993) Cu/Pd vs. Pd diagram for PGE prosecting reveals the highly mineralized transition zone dunite is the main Ni sulfide based PGE prolific zone.

Based on the preliminary geochemical and petrographic analyses of the different rocks and ore samples collected from the study area, magmatic processes are considered to be the major contributor in the deposition of precious and base metals in the Acoje Block. The role of the secondary hydrothermal processes also contributed, to a certain extent, in the remobilization and accumulation of these minerals.

12. FLOCCULATION OF MELANOIDINS BY INORGANIC CATIONS: A MODEL BASED ON ELECTRICAL CHARGE EFFECTS

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Natural melanoidin in alcohol distillery effluent and synthetic melanoidin, which was prepared from glucose and glycine, showed similar elemental (CHON) composition and electrophoretic mobilities at various pH values. Optimal flocculation by $FeCl_3$, $AlCl_3$ or polyferric hydroxysulfate was obtained at a trivalent cation concentration of 0.04 M; excess flocculant caused color intensification. Based on the electrical charge properties of melanoidins, a model is proposed for their flocculation and deflocculation by inorganic ions.

13. FOUR-YEAR OVERVIEW OF LAHAR ACTIVITY ON THE WEST SIDE OF MOUNT PINATUBO

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The 1991 eruption emplaced 5-7 km^3 of pyroclastic flow materials on the Pinatubo slopes, the Marella River and Bucao-Balin Baquero River watersheds on the west side of the volcano, respectively, receiving 1.3 km^3 and 3.1 km^3. Of these materials, 0.715 km^3 and 1.705 km^3 are expected to be remobilized as lahars along the Marella-Santo Tomas and Bucao-Balin Baquero channels, respectively. As of 1994, the total sediment transported into the Santo Tomas depositional basin was about 0.562 km^3, while the Bucao received 0.823 km^3.

Hot lahars are initiated by intense rain on the pyroclastic materials metastably perched on the volcano flanks. In 1991, triggering rainfall intensity and duration threshold values were 0.21-0.24 mm/min sustained over periods > 30 min. Other lahars are triggered by mass failures from hydrothermal explosions when runoff percolates into hot pyroclastic materials. Equally devastating secondary lahars are triggered by sudden lake breakouts from lahar-dammed non-Pinatubo tributaries such as the Mapanuepe River Lake in San Marcelino, Zambales.

The lahars display a continuum of flow types: hyperconcentrated (as precursory surge and principal flow); debris flow (commonly multiple with intervening hyperconcentrated flow): and waning hyperconcentrated flows. Flow densities were typically between 1.4 to 1.5 g/cm^3, lesser than the 2.0 g/cm^3 of debris flows observed at Mayon Volcano and elsewhere. This is because pumiceous sediments with typical densities of 1.3 to 1.75 g/cm^3 or even < 1 g/cm^3 largely constitute the solid phase. Measured from the edges of the flow, hot lahars average 45°C in temperature; maximal values were 75-80°C in 1991 and 1992, declining to an average of 32°C by 1993 due to the cooling of pyroclastic flow deposits.

Overall, channels have experienced vertical erosion on the upper reaches, aggradation, lateral erosion, and some vertical erosion of debris flow along the middle reaches, and a continuous aggradation along the flat alluvial plain downstream. By the end of 1993, lahars had aggraded to the level of the highest pre-1991 lahar terraces along the Santo Tomas and Bucao Rivers. Rapidly aggrading lahars blocked a non-lahar channel, forming the Mapanuepe Lake in San Marcelino; frequent lake breakouts continue to generate serious flash flooding and secondary lahars.

Complex, dynamic lahar behavior and resulting rapid geomorphic changes have required the detailed, frequently updated lahar-hazard scenarios over time, and indicate the diminution rate of lahar activity for the future.

14. PETROLOGICAL AND GEOCHEMICAL CHARACTERIZATION OF THE CAMARINES NORTE OPHIOLITE COMPLEX, SOUTHEAST LUZON

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The CNOC is an exhumed oceanic crust-upper mantle assemblage composed of, from base to top, residual and cumulate ultramafic rocks, layered gabbros, sheeted volcanic complex, and pillow basalts. The ophiolite is thrust above an amphibolite unit and capped by a clastic sequence composed of shale, quartz-rich conglomerate, and quarts-rich sandstone.

The principal residual ultramatic rock is an aluminous and chromian spinel bearing harzburgite which exhibits protogranular and porphyroclastic textures. Websterite and minor orthopyroxenite are the dominant ultramafic cumulate units. The not extensively exposed layered mafic sequence is composed mainly of gabbro and olivine-bearing gabbro. Closely associated with the layered gabbros are minor anorthosite pods.

In transitional contact with the isotropic gabbros are patches of sheeted basalts and diabases. The latter is in turn intruded by gabbroic dikes. The pillow basalts are mineralogically comparable to the basalts of the sheeted dike complex and are generally vesicle free.

Preliminary mineral chemistry data from the residual harzburgite indicate that the CNOC restites have undergone relatively lower degrees of partial melting (100XCr =32.9 to 43.88).

Constraining the petrological and geochemical make-up of the CNOC could be a very important tool in the evaluation of the complex with respect to primary ophiolite-hosted mineralization and the evolution of the Bicol Peninsula basement.

15. SOUTHEAST BOHOL OPHIOLITE COMPLEX, VISAYAS, PHILIPPINES: A FOREARC TO BACKARC SUPRA-SUBDUCTION ZONE OPHIOLITE COMPLEX

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The Southeast Bohol Ophiolite Complex (SBOC) as exposed in Bohol Island is made up of residual (?) harzburgite layered clinopyroxenites-harzburgites-dunites, massive gabbros, sheeted diabase to dioritic dike/sill complex, basaltic lava flows and pillow with associated cherty sediments. Tuffaceous ash layers-layered gabbro floats are also deposited and have been encountered (Diegor et al., 1994). Amphibolite schists, chlorite-mica schists, and phyllites are also noted as floats. This metamorphic assemblage is believed to correspond to the associated metamorphic sole of SBOC. These metamorphic rocks are not genetically related to the regionally metamorphosed Alicia Schist. Initial whole rock geochemical analyses show the presence of high Mg-andesites of probable boninitic affinity, and alkaline rock. In the island are theoliites and mid-ocean ridge basalts. The presence of relatively large-scale strike slip faults (PHIVOLCS data, 1994), the accompanying structural characteristic of the outcrop, and the presence of rocks of varying affinities suggest that this ultramafic-mafic complex could have formed in a forearc environment. Regional consideration of ultramatic arc in Cebu and the lithological distribution of the SBOC suggest the presence of a Cretaceous (?) NE-SW trending paleosubduction zone southeast of Bohol Island. However, the present-day configuration and distribution of tectonic elements show the SBOC to be on the backarc side of either the present day east-dipping Manila Trench or west-dipping Philippine Trench.

The perceived Cretaceous (?) paleosubduction zone is believed to be responsible for: (a) the formation of the magmatic arc and associated mineralization in Cebu, (b) the observed discontinuity of the proto-Philippine Trench in the Visayan Region (triple-point junction), and (c) the emplacement of the SBOC either through ontramping or accretionary processes (offscraping or lateral accretion).

Geochemical, paleontological, and a more detailed field mapping of this ophiolite complex planned for the future will definitely answer some of the questions we have to present.