PhD 2011 – RESEARCH TOPICS – projects 1-11
Science and technology – curriculum Earth Sciences

PROJECT n.1 Synthesis and structural characterization of new phosphate-silicate glasses for advanced technological applications
Supervisor: Dr. Gabriele Giuli – prof. Eleonora Paris
Stipend available: MIUR – progetto giovani
Research financed by grants: G.Giuli – E. Paris
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Materials containing vanadium oxides find many technological applications (as for sensors, catalysis, electronic devices, glass ceramics. The interest towards vanadium oxides derives from the variety of oxidation states (from V2+ to V5+) and bond geometries present both in crystalline compounds and glass structures. This variety opens a complex range of structural roles and derived physical properties which are not well understood and stimulates therefore a strong interest on the study of this element. The idea at the basis of this project is to produce and study phosphate-silicate glass systems containing vanadium with pre-determined oxidation state and structural role, with the aim to control the resulting physical properties. This will be achieved by the synthesis at high T and controlled atmosphere of glass compositions, structural study by XAS spectroscopy, determination of physical properties. In particular it will be investigated:
1) how the structural role of V in the glass can affect the physical properties (viscosity, density, electrical conductivity....) 2) how the glass composition and synthesis conditions affect the structural role of vanadium.
The reaching of these objectives will allow to program and produce materials with desired physical properties The project includes periods of experimental work at ESRF (F) and LMU-Muenchen (D)

PROJECT n.2
Analisis of coastal dynamics in the southern Marche Region through monitoring.
Supervisor: Proff. Gino Cantalamessa – Carlo Bisci
Stipend financed by: RITMARE
Research financed by grants: proff. Gino Cantalamessa – Carlo Bisci
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The project aims to study coastal dynamics in the southern Marche area (from the Conero Mt. to the Tronto R. mouth), where the sandy-pebbly beaches of a relevant social-economic value are interested by widespread and locally intense retreat phenomena.
This situation brought in the last decades to the construction of several protection works of different types, that lead to a more complex interaction of sea waves and longshore sediment movement.
To analyse this phenomenon, both analyses of historical maps and photos and systematic monitoring of changes of local topography will be carried out. The results of these studies will be used to feed a multithematic geodatabase that, in turn, will be used to individuate evolutionary trends.

PROJECT n.3
Sedimentological and stratigraphic characterisation of carbonate rocks and their reltionship with failure modes and fracture distribution

Supervisors: Dr. Claudio Di Celma and Prof. Emanuele Tondi
Stipend available: PRIN Tondi
Research financed by grants: PRIN Tondi
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Carbonates are represented by a considerable variety of lithotypes, based on the nature and organization/shape of the constituting elements and are characterised by different values in porosity and permeability, in relation to their digenetic evolution. During this process, the porosity of carbonate rocks can vary in unpredictable ways, according to the biological phenomena that control the composition and texture of the initial sediments.
The digenetic phenomenon of dolomitization, in particular hydrothermal and/or epigenetical, determines a considerable impact upon the evolution of the physicalmechanical properties (and therefore porosity) of carbonate rocks. In general micritic and massif limestones, as well as dolomite rocks, will present low porosity values and form rather impermeable structures, whereas grainstones present high porosity and fluid conductibility values.
Furthermore, the storage and migration of geofluids in carbonate rocks is strongly influenced by "fracturing" or, better, by the presence and characteristics of bedding,joints, veins, stilolites and fault zones. The different deformation processes and their capacity of increasing or inhibiting hydraulic conductibility in carbonate rocks, are controlled by the physical-mechanical properties of the rocks, and are the result of different sedimentation environments, digenesis and alteration state.
This PhD project aims to explore the relationships existing between compositional, depositional, and diagenetical rock features and the physical-mechanical properties of the rocks and, as a consequence, the different failure modes and fracture distributions in carbonate rocks.

PROJECT n.4
Kinematic model of Tyrrhenian extension, in relation to the migration of the Apenninic arcs
Supervisor: prof. Eugenio Turco
Without stipend
Research financed by grants: PRIN E.Turco
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The project aims to obtain a 3D quantitative tectonic reconstruction of the Tyrrhenian Sea extension and the contemporaneous migration of the Apenninic arcs. This will be accomplished through a compilation of a new kinematic model of the Tyrrhenian-Apenninic area, which will be included in the global rotation model of the major platessurrounding the Mediterranean area.
The model will be built using the classic methodology of plate kinematics, commonly adopted in global tectonics studies. In these reconstructions the relative motion between two plates is typically based on the analysis of the marine magnetic anomalies, which allow to determine the kinematic parameters of relative motion. When the tectonic elements are represented by microplates, marine magnetic anomalies are seldom available, and the determination of the model parameters requires a careful and analysis of geological and morpho-tectonic data. The effort required to build these models is largely rewarded by their capability to be assessed through a comparison with the predicted geological structures and to explain the observed processes of formation of basins.

PROJECT n. 5 Effects of meteorite impacts on oxidation state, melt water contents and processes of impact glass formation Supervisor: Dr. Gabriele Giuli Co-supervisors: Prof. E. Paris, Prof. Michael Carroll, Prof. C. Koeberl (Univ Vienna, Austria) Stipend not available yet: ASI-Italian Space Agency (submitted proposal) Research financed by grants: G.Giuli, E. Paris Info: gabriele.giuli@unicam.it

The project regards the study of atomic-scale structural properties and geochemical characteristics of natural glasses produced following meteorite/asteroid impacts on the Earth. The major goal of the research is to use the unique characteristics of impact glasses to better understand the conditions of their formation (a process believed to be
important in the evolution of all of the terrestrial planets. Training will be provided in advances analytical techniques, including X-ray absorption spectroscopy, microanalytical FTIR and Raman spectroscopy, trace-element geochemistry, and theoretical aspects of models of meteorite impact processes.

PROJECT n. 6
Research on teaching and learning processes in Earth Sciences education
Supervisor: Dr. Chiara Invernizzi - prof. Eleonora Paris
without stipend
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Development of new approaches to teaching and learning Earth Sciences through new instruments and models, and/or by inquiry-based science education (IBSE). Development of teaching in an optics of integration of different scientific disciplines with attention to environmental sustainability (educational background in Geology or Environmental/Natural Sciences is appreciated). Strategies to address perceived problems in Earth Sciences teaching, engagement of young people with Earth Sciences and Geoenvironmental resources and risks, development of teaching materials will be some of the objectives of this research topic.

PROJECT n. 7
Plate kinematics of Iberia since the late Triassic
Supervisor: Dr. Antonio Schettino
Without stipend
Research financed by grants: A. Schettino
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This research program has the objective of determining a newreliable rotation model for the Iberian plate from the break-up of Pangaeaonward. The student will perform an analysis of marine magnetic anomalies,seismic profiles, paleomagnetic, geochemical and geologic data in aninterdisciplinary approach to the reconstruction of the tectonic history of the area north of the Azores triple junction, comprising the conjugatemargins of Iberia and new Foundland, the Biscay bay, the Gibraltar fault zone, and the Pyrenean range. The student will also investigate the tectonic consequences of his reconstructions for the western Mediterranean area.

PROJECT n. 8
Kinetics of crystallization in silicic magmas

Supervisor: Prof. Michael Carroll
Without stipend
Research financed by grants: M. Carroll
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Experimental and theoretical data are needed to define time scales for magmatic processes (residence, ascent, eruption), at Stromboli volcano and with possible application to other basaltic systems. To obtain information on the dynamics of the system from the textural variations observed, we need quantitative data on the rates of nucleation (J) and growth (G) for crystal composition, pressure and temperature of interest. In this project will be studied the mechanisms and the growth rates of minerals in magmas, by carrying out experiments at high temperature and pressure to determine the parameters which controls the growth/nucleation rates. The PhD student will carry out the research in collaboration with the Universita' di Pisa (prof. Armienti, project PRIN). The student will perform the experiments in Camerino, but will also spend time in the labs at INGV (Roma) and possible periods at the Osservatorio Vesuviano, Stromboli and Iceland.

PROJECT n. 9
Tradition, innovation and eco-sustainable techniques for cement materials
Supervisor: Prof. Eleonora Paris
Without stipend
Research financed by grants: E.Paris
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Materials like “pozzolana”, fly ash, silica fume and furnace slags have been used for years in the cement industry for the preparation of binders and concretes with interesting results, often producing improvements of specific physical properties.
much less well-known and investigated is the use, for the same purpose, of ceramic waste materials although they can present properties very similar to those of “pozzolana”.
This research project involves the study and characterization of a cement or conglomerate containing such materials, with properties suitable for using in the building works. The general aim of the project is to improve the environmental sustainability of the process extraction-production-application for cement materials.
The project includes:

- the characterization of the materials suitable for this purpose
- the determination of a productive cycle
- the experimental verification of the physical, chemical and mechanical properties

PROJECT n. 10
Archeometrical study of medieval ceramic from Umbria - Marche.
Supervisor: prof. Eleonora Paris
Without stipend
Research supported by: E. Paris
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This project is focus on the archeometrical characterization of ceramic materials from archeological medieval sites of the Umbria – Marche area. The study of Medieval ceramic has been disregarded for years as not interesting enough for the archaeologists who concentrated their attention on the roman ceramic production.

The recent increase of interest for this part of the Italian history pointed out the attention on the ceramic manufacts, because they represent a transition between the Roman classical production and the ceramic production typical of the renaissance period, during which ceramic production centers flourished in all central Italy and are still active (e.g. Deruta, Orvieto, Gubbio….). The interest of the archaeologists is aimed at determining if these materials were produced locally, suggesting a continuity of production with time, in many sites. Also no information are available on the technology related to the ceramic production (components, temperatures, porosity, decoration) which the mineralogical, petrographical and chemical methods can address.

PROJECT n. 11

Sustainable energy development: exploration of medium to low enthalpy geothermal resources

Stipend not available yet: possible involvement of a private company

Supervisors: dr. Chiara Invernizzi, prof. Michael Carroll, dr. P. Pierantoni
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The fundamental objective of the proposed research is to identify and quantitatively characterize geothermal systems that can be developed in a sustainable way in urban areas located at distances of several tens of kilometers from potential sources of geothermal energy. The research will involve application and development of integrated, multi-disciplinary methods to the quantitative evaluation of potential sources of low to medium enthalpy (temperature <100°C) geothermal energy, to be developed in a sustainable way in urban areas located in central Italy and in Argentina. The principle methods of study will involve: (1) regional geology, structural geology and controls on fluid flow and abundance (e.g., fractures, fluid flow hydraulics controlled by permeability gradients, lithologic variations, etc), including sub-surface geophysical/geochemical measurements; (2) studies of fluid inclusions to characterize fluid chemistry, past and current fluid flow regimes; (3) geochemical studies including dissolved salts and stable isotopes in order to characterize fluid origins and mixing with superficial, cooler water sources.