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Session: Tectonic Geomorphology

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STATE OF THE ART

Let us present this state of the art as a short and a quick questionnaire. First of all, What would we understand as tectonic geomorphology? In a short statement, we may define it as an earth sciences discipline that studies the interaction of tectonic and geomorphic processes. That is to say that it describes and explains how tectonics and landscape evolution interplay. Therefore, the assessment of landforms may reveal what tectonic processes is going on a given region or viceversa: how tectonics affects or modifies earth surface ot topographic relief. Since this discipline is a key bridge between tectonics and geomorpholgy, it is tacit that it obviously requires either a multidisciplinary approach or a good knowledge of both fields.

How old is this discipline? It is very likely that the term «tectonic geomorpholgy» might be rather recent but its practice is very old. For over a century now, the study of landforms has been useful in demonstrating the occurrence of tectonic activity. For instance, either erosional surfaces or staircased alluvial terrace systems (planar features) have been currently assessed in Europe since the beginning of this century in order to prove ongoing regional tectonic uplift. Seeking the same objective, in more recent times, raised Quaternary marine terraces have been studied worldwide after the fast progress in the understanding of the behaviour of the Earth's hydrosphere as a straightforward result of the Deep-Sea Drilling Project -DSDP-. Almost simustaneously, in the 1960's and 70's, many others geomorphic (linear) features were recognized along seismically-active strike-slip faults, basically in California (after information mainly published in the western hemisphere; without neglecting other contributions from countries such as the former Soviet Union, New Zealand, Japan or China), which applied to other areas of the world allowed the recognition of such active features. This knowledge progressively generated the basis of the neotectonic approach in seismic hazard assessment.

Which is its main application? I would say that it is the seismic hazard assessment of a given region, without neglecting other potential areas of contribution such as: the understanding of subsiding or uplifting coastal areas that have an important impact on coastal regression or progradation respectively, which in turn has big implications for urban areas in coastal lowlands. Sea invasion or erosion is of big concern for such seashore settlements.

What are the future needs? Since its main applied field is seismic hazard assessment, the present trend should lead to a better quantification of deformation slip rates. This needs the improvement of age determination of geomorphic/geologic markers and more accurate assessment of amount of deformation. Nevertheless, some steps forward have been made in that sense in the last two decades, which we are to discuss next.

What are the present trends and progress? Regarding accuracy on quantification of deformation, several techniques have developed lately, closely linked to the quick development of electronics. Precise levelling of active tectonic areas has improved amazingly from the launching of satellites around the Earth, allowing the development of either systems such as the Global Positioning System -GPS- with accuracy of few milimeters, used worlwide to establish slip rates of major plate boundaries or high-precision levelling along topographic profiles across active areas of the world;

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or techniques such as the interferometry which calculates the ground deformations associated to an earthquake. Regarding age accuracy and new-datable materials, a big jump forward has been achieved in recent times. For instance, new techniques are becoming widely used such as:

Thermoluminiscence (TL) or Optical Stimulated Luminiscence (OSL) that can date sun-exposed quartz or feldspar grains of eolian or alluvial deposits;

Accelerometer Mass Spectrometry (AMS) that requires smaller amounts of datable materials;

Cosmogenic nuclides (10Be, 26Al, 3He) that can be utilized to date geomorphic surfaces such as: alluvial fans, lava flows and piedmont deposits;

Electron Spin Resonance (ESR) and U-series geochronological studies that are widely used to date corals imbedded in staircased marine terraces.

CARLO BARTOLINI

COMMENTS ON ORAL PAPERS PRESENTED

TECTONIC GEOMORPHOLOGY, SESSION I, SATURDAY, AUGUST 30, MORNING

The main topic of this session concerns the vertical movements appraisal as evidenced by marine terraces and paleosurfaces investigations. The studied areas span from the Ligurian coast (L. Carobene & *alii*), to Tavoliere di Puglia (F. Boenzi & *alii),* to the Crotone peninsula, Calabria (U. Hassler & *alii*), to north-eastern Japan (S. Yamashita). Dating is once more proven to be crucial.

A. Amato studied both the marine terraces and the erosional surfaces' relics of the Southern Apennines; she states that, on the time scale of the whole Pleistocene, a generally increasing trend in uplift rate occurs, which can be estimated, on average, at 0.25 mm/a.

H. Weingarter and E. Hejl studied the paleosurfaces of Northern Greece; the morphologic survey is supported by fission track dating for which, unfortunately, no details whatsoever are given.

Due to their very wide scope, the other posters have been arranged according to their geographic setting.

The first group relates to the Americas and includes:
- a study, carried out by an English team (O.G. Kimber & *alii*), on the rôle played by structural discontinuities on the morphology of steep slopes in the Colorado Plateau, USA;
- a morphostructural survey of the Campos do Jord‹o tropical plateau, SE Brasil, by M.C. Modenesi-Gauttieri & *alii.* Since no information is given on the lithology affecting the morphologic features, one wonders if some of them could be interpreted as due to morphoselection rather than to recent tectonic movements. As a matter of fact the last documented tectonic activity in the area dates back to Miocene times;
- the morphotectonic studies carried out in Argentina on the Plateau de la Pampa by T. Vogt & *alii* and on the La Cruz-Gibena depression by S.B. Degiovanni & M.P. Cant, which reveal a marked Quaternary alteration of the drainage pattern, following recent uplift movements.

The second group, regarding Asia and Africa, includes:
- a 3D numerical method developed at the Grenoble University for modelising fault propagation folds (P. Leturmy & *alii*);
- a morphostructural study of the outstanding relief forms which characterize the Gobi Altay horst and the Khangay area, Mongolia (T. Zietara);
- a well documented analysis of fault block movements induced by the 1995 Kobe earthquake (M. Hirano);
- a novel attempt to elicit the neotectonic events which have affected the Nile delta since Late Miocene from isopach maps of different sedimentary units (E. Abd El-Motaal).

TECTONIC GEOMORPHOLOGY, SESSION II, SATURDAY, AUGUST 30, AFTERNOON

The Session is devoted to European morphotectonics. Several presentations deal with the Apennines or with related chains such as the Ligurian Alps and Sicily mountains. Our review will start with these.

A. Biancotti & M. Motta present an overview of the Plio-Pleistocene morphotectonic evolution of the Ligurian Alps; special attention is given to the impact of tectonic movements on drainage alterations. A similar approach is followed by Boni & *alii,* who analyzed a neighbouring area in the northwestern Apennines.

P.P. Putzolu carried out a quantitative geomorphic analysis of northern Garfagnana and south-eastern Lunigiana (Northern Apennines); the results are matched with

the pattern of joints. The claim that the segments of the lower order are «associated with probable more recent deformations» should be matter of debate.

D. Aringoli & *alii* investigated the impact of Quaternary tectonics and uplift on large mass movements affecting the Adriatic side of the Central Apennine. Rather surprisingly, these authors state that a low energy relief was formed in an earlier phase of the Apennine evolution («probably during Middle-Upper Pliocene») as a consequence of a «huge uplifting». A limited portion of the same area (namely the southern Marche region) was the test site for an investigation, carried out by C. Bisci & *alii*, on digital shaded-relief maps as an aid to morphotectonic analysis. A previously unknown fault system oriented ca. N105° E was detected. The Quaternary evolution of the Marche-Abruzzi peri-Adriatic belt was also scrutinized by S. Bigi & *alii*; they give evidence of Middle Pleistocene uplift rates ranging from 0.8 to 1.0 mm/a. Such values match the average Northern Apennine denudation rate (0.77 mm/a) worked out from present day yield of rivers by Bartolini & *alii* (1996).

A paper of mostly methodological scope is that by F. Belisario & *alii,* aimed at unravelling the extent of tectonic control on hydrographic patterns. The authors state that «tectonics control the drainage network pattern in a way which differs with varying stream order; that is, stream channel of lower orders, which are likely to have joined the net in a later stage of its development have resulted to be controlled mainly by tectonic lines active in very recent times». As already mentioned, this should be a matter of debate. A second aim of the study is to verify whether the activity of strike-slip faults resulted in areal variations or rotation of the preferential stream orientations. The method was applied in two test sites, Val Roveto (Latium) and a non specified area of Tuscany.

An outline of the geological and geomorphological evolution of the Sulmona intermontane basin (Abruzzi) is presented by Ciccacci & *alii.* The authors point out that the sequence of events may be considered representative of the Middle Pliocene - Quaternary evolution of the Central Apennine.

In their paper on the Madonie Mountains, V. Agnesi & *alii* underline the relevant rôle played by selective erosion on the present day morphology of the area.

Last, but not least, is the novel approach to seismic event chronology proposed by M. Pelfini & *alii.* The team sampled 300 *Pinus laricio* specimens in order to detect ring structure deformations in the vicinity of the Pernicana fault, Mount Etna. Periods of stress repeated over time and of varying intensity were evidenced.

Six more posters deal with the morphotectonic outlines of areas spanning from the Eurotas Valley, Peloponnesus (H. Maroukian & *alii*) to Western Carpatians (M. Baumgart-Kotarba), from Western Crete (A. Peterek) to the Massif Central (E. Define & *alii*), from the Pannonian Basin (J.F. Dumont) to the Guadix Basin (A. Rebeiro-Hargrave).

All the features identified by H. Maroukian & *alii* and by A. Peterek are interpreted as tectonic relief forms; one wonders what possible rôle selective erosion could have played, instead.

The poster by E. Define & *alii* is a remarkable outline of the morphotectonic evolution of the Loire and Allier valleys since Early Pliocene; special attention is given to the bioclimatic factor.

Also J.F. Dumont, who studied the Pannonian Basin as well as two basins of the Peruvian and Bolivian Subandes, affords the crucial topic of tectonic versus climatic impact. In his concluding remarks he states that, during a period of relatively dry climate, a lower discharge leads to underfit channel patterns; at the onset of a wet period, the increase of discharge favours river mobility and overpassing of the previous underfit traces. Accordingly, at least in the two studied areas, it seems that drainage pattern evolution only occurs during wet periods.

A. Rebeiro-Hargrave reports on the results of cellular automata simulations of drainage evolution in half graben under semi-arid climatic regime. The test site area is the Guadix Basin, Southern Spain.

The tectonic processes which affected the Eastern European Platform as a consequence of ice sheet load are dealt with by V.N. Dubin.

All together a remarkable outlook on the world's morphotectonics. The rôle of morphoselection, however, sometimes appears underrated.