TENSIONAL AND COMPRESSIONAL AREAS IN THE RECENT (TORTONIAN TO PRESENT) EVOLUTION OF THE NORTHERN APENNINES

P. Elter, G. Giglia, M. Tongiorgi, L. Trevisan } Instituto di Geologia e Paleontologia, Dell'Universita di Pisa, Pisa, Italy

This communication is an attempt to determine the relations between surface geology and gravity anomalies, seismicity and crust-mantle boundary in the Northern Apennines.

In this orogenic belt a striking contrast exists between the inner (western) and outer (eastern) areas. The former has been submitted to strong tensional deformation which began in Upper Miocene and is still active. In the same time interval the crust of the eastern area has undergone compressive deformation.

The limit between the two areas significantly coincides with the passage from positive to negative gravity anomalies.

In the two cross-sections which have been examined in detail, the depth of the Moho varies from a minimum of 20 up to 46 km. Attenuation of the crust is related to rifting in the western part of the belt.

A short summary of the tectonic and palaeogeographic evolution of the belt will be presented, in which it will be shown that the development is probably related to a counter-clockwise rotation of the whole Italian peninsula. A hypothesis (based on convection currents in the asthenosphere) is advanced to explain the coexistence of the tensional and compressional movements in adjacent areas of the same belt.

TRANSCURRENT FAULTS IN THE WESTERN ALPS

R.H. Graham, Department of Geology, University College of Swansea, Wales, England
N. Fry, Department of Geology, University College of Swansea, Wales, England.

Interfering fold sets in the Mesozoic and Tertiary cover of the external alpine zone in south-east France have developed above major basement transcurrent faults, and provide information on their ages and displacements. These faults can be traced from Spain to the internal zone of the Alps and help define the relationship between Alpine tectonics and the opening of the North Atlantic. The effects of these faults on structural and metamorphic phenomena in the internal zones of the western Alps are described.

GEOPHYSICAL AND GEOLOGICAL CHARACTERISTICS OF THE ENSIALIC INTERARC BASINS

F. Horvath, L. Stegena, B. Géczy Eötvös University, 1083 Budapest, Kun Béla tér 2, Hungary

The comparison of the basins being situated at the concave side of the island/mountain/ - arcs shows that their geological and geophysical characteristics are very similar. It presumably hints at the similar tectonic evolution of the interarc basins. Karig developed a model for the formation of Western Pacific ensimatic basins which has been widely accepted. It is based upon the interarc-spreading generated by the upwelling partially melted mantle material/ "active mantle diapir"/. It is shown that this model is appliable for the formation of the ensialic basins too but with the following modification : the upwelling mantle material does not break through the crust but spreads laterally at the Moho surface and thins the crust below. The formation of the ensialic interarc basin is caused by the isostatic subsidence of the thin crust.

PLATE BOUNDARIES AND MICROPLATES IN ALPINE HISTORY.

H.P. Laubscher, Geologisch-paläontologisches Institut der Universität, Basel, Switzerland.

Palinspastic reconstruction starting from the present external margin of the Alps on the European continent results in the following inverse sequence of zones of deformation.

1. A Neogene belt of compression (Helvetic nappes, Jura, Subalpine chains), with components both NS and EW and at least 50 km of compression in these directions.
2. The northern and western front of the Paleogene Alps joining the Pyrenees-Provence belt with a compressive triple junction Alps-Pyrenees-Apennines somewhere south of Genova. It was not influenced by Tertiary counterclockwise rotation of Corsica-Sardinia which moreover is contradicted by several weighty arguments. The western Mediterranean basins fit into this scheme not through chaotic sea-floor spreading but through spreading into the neighbouring plates of the detachment of the upper crust from the rest of the lithosphere, ubiquitous in zones of compression.
3. A Lower Cretaceous to Middle Eocene sequence, most completely recorded in the Pyrenees, is associated with the Cretaceous opening of the Gulf of Biscay and subsequent movements. To the east these seem to have split into a zone of minor compression in the Provence-Devoluy-North Pennine to Ultrahelvetic zone, and into a main branch trending into the southern margin of the Piemonte trough.
4. In the Jurassic distensive movements, with discordant splitting of Triassic depositional realms.

A CRUSTAL SECTION ACROSS THE SWISS ALPS BASED ON GRAVITY AND SEISMIC DATA

H.-G. Kahle, E. Klingelé, R. Egloff, St. Müller } Institut für Geophysik, ETH-Hönggerberg, Postfach 266, CH-8049 Zürich, Switzerland

Recently determined gravity anomalies along the seismic refraction profile Steinbrunn (near Basle)-Lago Bianco (Ticino) and further to the south into northern Italy are used in combination with seismic refraction data to obtain a crustal section across the Swiss Alps. Free Air, Bouguer and isostatic corrections were applied to the data. The resultant Bouguer anomaly of the Gotthard Massif is 120 mgal lower than the values in the northern portion of the Swiss Molasse Basin. The variation of isostatic values corrected for the effect of the sediments in the Molasse Basin are relatively small indicating that the Swiss Alps are isostatically compensated. The southern segment of the profile is characterized by a relative gravity high suggesting the existence of an Ivrea type body that may be present under the southern margin of the Alps. Attempts were made to find an explanation for the observed present-day uplift of the Alpine zone with its maximum elevation (1 mm per year) south of the Gotthard Massif in terms of crustal structure concordant with the detailed gravity results.

STUDIES OF THE EVOLUTION OF DEFORMATION IN THE CENTRAL ALPS

John G. Ramsay, Earth Sciences Department, Leeds University, Leeds, England.

Studies of the structure of syntectonic veins and fissures which were filled by crystalline material during deformation have shown that the crystals filling the vein often have an anomalous fibrous habit. These fibres appear to be the result of progressive growth in certain directions controlled by the incremental strain history at the time of deposition. Several types of vein filling and pressure shadow filling have been recognised, and the geometric form of the crystal fibres enables the sequence of strain events during the deformation to be evaluated. These techniques have been applied to various localities in the Central Alps to reveal variations in deformation history at different levels in the nappe pile and in the autochthon.

RELATIONSHIPS BETWEEN TRIASSIC TETHYS SEAWAYS AND OCEANIC JURASSIC CENTRAL TETHYS

P. Scandone

The pelagic sequences of the Triassic Tethys "seaways" have been often interpreted as ocean floor sediments, and their distribution has been used to reconstruct a Triassic Tethys palco-ocean in the central Mediterranean area.

The Autor interprets the Upper Triassic seaways - from the Pindos zone in Greece to the Sicani zone in Sicily- as basins based on thinned continental crust, subsequent to Middle Triassic phases of abortive rifting. The Jurassic true ocean spreading in the Mediterranean area will not follow these Triassic lines of weakening, and the pelagic basins inherited from the former Triassic seaways will become an integrant part of the southern continental margin of the central Tethys.

THE PRESENT AND ANCIENT GEOPHYSICAL STRESS SYSTEMS IN THE HOCHKÖNIG MASSIF

A.E. Scheidegger, Institut für Geophysik, Technische Hochschule, Wien, Austria.

The stress systems which are and have been active in a welldefined calcareous mountain massif (the Hochkönig massif in Austria) were determined : (i) from joint orientations in the Paleozoic Basement, (ii) from joint orientations in the calcareous superstructure and (iii) from in situ stress measurements in a mine beneath the massif. It was found (i) that the stress system that produced the Paleozoic joint system is quite different from the other systems active in the area, (ii) that the joints in the superstructure correspond to a stress system which is in conformity with the general N-S thrust thought to have produced the Alps and (iii) that the stresses measured in situ represent nothing but the effect of present-day overburden topography.

A NEW HYPOTHESIS ON THE ALPINE OROGENESIS IN THE ITALO-DINARIC AREA

E. Semenza, Instituto Geologico Dell'Universita di Ferrara, Italy.

Judicarian and Voghera belts (middle-upper Pliocene) probably represent the front of a "small" Italo-Dinaric plate, which moved towards NW. Before this phase, three other phases of alpine orogenesis can be recognised. In the first one (Cretaceous-Lower Eocene) a 'large' Italo-Austro-Dinaric Plate moved towards NNW, whose impact with Paleo-Europe produced the first alpine arc. In the second phase (Upper Eocene-Lower Oligocene) the movement was confined to a part of this plate ('insubric plate') limited by the insubric, Canavese and 'antisubric' (now buried) lines. This plate moved with a counter-clockwise rotation, strongly compressing the western and also the Central and Eastern Alps and the Dinarides. The subsidence of a basin into the plate (Macigno basin) and the first folds of the Apennines are also related to this movement.

In the third phase (Miocene) the counter-clockwise movement of the Corsica-Sardinian Block provoked : 1) a strong compression of the Apennine area; 2) the displacement of the subsidence basin (Marnoso-arenacea b.) towards NE; 3) a new compression in the eastern part of the Alps, with arching phenomena; 4) the probable cutting of the Po Plain and southern Alps by a 'Judicarian paleo-line', whose step acted in the following Pliocene phase as an obstacle for the 'small' plate moving tpwards NW.

THE DEVELOPMENT OF SLATY CLEAVAGE IN A PART OF THE FRENCH ALPS

A.W.B. Siddans, Department of Earth Sciences, The University, Leeds, England.

The progressive development of slaty cleavage in argillaceous formations was studied along a traverse through the external zone of the French Alps between Die and Embrun. Various changes were found to be associated with the slaty cleavage development :

1) Finite strain states, measured using deformed fossils
2) Metamorphism, measured by the crystallinity index of illite and the ratio of illite polymorphs 2M/1Md.
3) Textures as seen using the optical and electron microscope and measured by texture goniometry.
4) Minor structures.

The geologic history of the area is reviewed and a hypothesis for the origin of slaty cleavage in this region is presented.

L'EVOLUTION DE L'ARC DES ALPES OCCIDENTALES EST-ELLE CONTROLEE PAR DES FAILLES DE COULISSEMENT DU SOCLE ?

P. Vialon, Grenoble, France.

L'étude des virgations primaires du clivage schisteux régional des couvertures des massifs cristallins externes des Alpes occidentales, conduit à définir la situation et le role de grandes fractures de socle de direction N 50°E, continuation dans le domaine alpin des failles cévenoles du Massif Central français.

Dés le Trias ces failles profondes et anciennes déterminent les zones où apparaissent préférentiellement les dykes doléritiques, cheminées des coulées volcaniques du Trias-Lias. Pendant cet épisode magmatique les transformations hydrothermales et les contaminations entrainent la spilitisation des coulées et un léger métamorphisme statique (semblable à celui d'un fond océanique) dans le socle cristallin.

Après cette phase d'expansion les bassins sont soumis pour leur sédimentation comme pour leur direction, aux mêmes orientations. De même, les premières déformations, crétacées, à plis E-W et chevauchements vers le N où le socle est impliqué, sont déviées et courbées le long de la direction N 50°E. Ces failles ont alors un jeu coulissant anti-horaire. A cette époque existe un gradient de déformation et/où de métamorphisme en direction de l'Est et du Sud.

Au Tertiaire, entre l'Oligocène et le Miocène, puis parès cette époque, s'enchainent des déformations provoquant l'aparition de deux clivages schisteux successifs. La contraction est plus fort, les déplacements senestres le long des failles profondes sont d'abord accentués et la courbure des plis de couverture qui en découlent également: les virgations à convexité vers le N et le NW, avec chevauchements et chariages plus importants, apparaissent. La fin de cet épisode est marquée par les surrections générales, accompagnées par des contractions locales de direction E-W avec chevauchements vers l'Ouest, basculement des anciennes structures et nouveau clivage par pli-fracture. C'est avec cette suite de déformations tertiaires que se développe le métamorphisme, léger dans les zones occidentales, plus fort dans les zones plus internes, généralement désigné sous le nom de métamorphisme alpin, mais qui n'est que le dernier de cette évolution.