THE USE OF ERS-1-SAR- AND LANDSAT-TM- DATA FOR STRUCTURAL ANALYSIS IN THE SOUTH PATAGONIAN MASSIF

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1. Introduction

The tectonical development of the South Patagonian Massif during Mesozoic and Cenozoic times stands in close relation to the break-up of southern Gondwana and the opening of the South Atlantic Ocean. Kinematic analyses and the reconstruction of the stress fields which existed in these times will also characterize the position of the Massif within the supercontinent, which isn't still sufficiently cleared. Generally little information about postjurassic tectonics of the South Patagonian Massif has been published.

The isolated situation and extension of the South Patagonian Massif and the lack of geologic maps and topographic sheets of a suitable scale requires the use of remote sensing data. Furthermore the smoothly reliefed landscape of the test sites with a vegetation density of no more than 50 % facilitates the application of radar and multispectral systems. These means enable the geologist to record regional and supraregional trends of lineaments, fault- and jointsets, finally to correlate this information to the microtectonic analysis of the field check in order to reconstruct the paleo-stress fields. The test sites represent the central part of the South Patagonian Massif. Here mainly Jurassic and Cretaceous volcanic rocks build up large plateaus which show intense brittle deformation caused by several states of stress. Magmatism and tectonical deformation stand in close relation to each other. An improvement of the discrimination of alteration zones and their assignment to tectonical features will give further information of the stress dynamics of the Upper Jurassic and early Cretaceous. In this matter parallel to the petrographic studies spectral analysis of several samples of alterated rocks will be studied and correlated to the spectral information of Landsat-TM.

Comparing ERS-1-SAR- and Landsat-TM – data sets the structural inventory can be traced more accurate. In contrast to optical systems radar has its own illumination source which operates at much lower frequencies and penetrates clouds, dust or even soil and vegetation cover. Additionally the SAR antenna of ERS-1 looks obliquely to one side of its ground track and therefore simulates a topographic sharpening which emphasises certain directions, in this case N-S trends, which play an important part in the South Patagonian Massif.

2. Techniques

The structural interpretation of ERS-1-SAR – images based on an adaptive speckle filtered data set (Lee, 1980; Frost et al., 1982 and Kuan et al., 1985) and of various Landsat-TMprocessings (Mehl et al.,1993). Most suitable for lineament mapping was TM-relative-band 3 and the combination of band 2 with band ratios of band 3/band 4. All images were linearly stretched, enhanced by an Adback-Highpass filter and visually mapped from black and white prints in a scale of 1:120,000. Additionally the lithological units were differentiated by Landsat-TM – RGB colour composites. In a further step the lineaments were digitalized separating different stratigraphical units, in order to distinguish fractures in time and space. To compare the lineament pattern with the outcrop data referring to certain trends and orientations all measurements were plotted in distribution diagrams due to their quantity per 5° intervals (Henkel, J. 1982). Finally suitable subimages have been mapped in detail also aided by aerial photographs to correlate the outcrop data to the main and also to the minor deformation pattern which are not always detectable on satellite imagery (Margane & Böck,1992). All measurements have been analysed individually and plotted as contour diagrams. In some cases measurements of analogous outcrops with respect to their stratigraphical position and spacial closeness but of differing lithology were summarized to obtain all deformation pattern of the same age. Here especially the strong anisotropy of ignimbritic rocks (cristallization degree, alteration) as the most common ones in the test areas causes variable fracturing.

3. Results

Fractures of the first and second deformation system are well detectable on Landsat-TM and ERS-1-SAR imagery, in the SAR images also those beyond clouds and some soil covering. Generally radar sensors emphasise topographical (structural) features with sharp angular boundaries which serve as corner reflector even where a corner reflector is much smaller than the resolution cell (Drury,1987). Thus new lineament patterns have been mapped which don't only complete those derived from TM-data but also accentuate absolutely new ones. Even E–W striking structures were distinguished, of which it was supposed that they were generally underrepresented in the SAR images. As mentioned above, possibly aligned corners along these structures helped to highlight the linear features and thus to map them as lineaments. Minor jointing of the 3. and 4. deformation system is less resolved in both satellite imageries and must be extracted from aerial photographs. In contrast to the main fault sets conjugated joints or shears are more frequently developed which will also appear in the distribution diagrams of the outcrop data. Considering the different ways how ERS-1-SAR and Landsat-TM operate and considering the anisotropic character of the rock body which will lead to variable fracturing, the overall structural inventory can therefore only be analysed in a comparative examination of all evaluated data sets.

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THE EFFECT OF TRANSMAGMATIC FLUIDS IN THE EVOLUTION OF HERCYNIAN OROGENIC MAGMATIC ACTIVITY IN THE CENTRAL TIEN-SHAN (CENTRAL ASIA)

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The Kurama Volcanic Belt in the Central Tien-Shan is a segment of the crust with extensive magmatic activity of various ages characterized by a specific metallogeny.It represents a typical example of epithermal fluid-magmatic systems of Hercynian age. It is proposed that there is a substantial association of three depth levels of the system: (1) deep mantle-core magmatic chamber, (2) abyssal granitoid batholith, (3) subvolcanic granite-porphyry intrusions that initiated the formation of a part of ore deposits. The interconnection of these levels is due to transmagmatic fluids that initiated magmatic differenciation and carried some ore components from the deepest levels.

The Kurama epithermal system was formed in Hercynian time at an orogenic stage. Extensive granite-porphyry intrusions (C_3 – P_1) intersect and replace granites and diorites of the Karamazar abyssal batholith (C1-23). In both the batholith and porphyry intrusions activity of transmagmatic fluids appeared. These are: (1) Mg-K metasomatism of magmatic stage in the exocontact zone of porphyry intrusions and magmatic replacement of host rocks by syenite-diorites, (2) appearence of large porphyroblasts (megacrystals) of orthoclase in various dykes of porphyries, (3) K-feldspathization of a magmatic stage in linear zones inside the batholith, (4) significant shift of eutectic point in the quartz-feldspar system during the magma evolution, (5) specific features of geochemistry of porphyry intrusions. Transmagmatic fluids had a high activity of potassium and at the final stages that of fluorine. It caused a considerable differentiation of magmas, formation of ignimbritic chambers, intense magmatic replacement of host rocks and intense hydrothermal activity including ore deposition.