4.9.2. GEODYNAMICS AT THE ALPS – DINARIDES JUNCTION IN SLOVENIA AFTER GEOLOGICAL, SEISMOLOGICAL AND GEODETIC DATA

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ABSTRACT

Central Europe Regional Geodynamic Project (CERGOP) in Slovenia includes GPS measurements on 5 sites. Within the first part of the project during years 1994-1997, measurements were performed on one site (Ljubljana), and during the CERGOP-2 extension in years 1999-2005 additional 4 sites were added (Božica, Malija, Snežnik and Mrzlica). However, till now measurements on the three sites only (Ljubljana, Božica and Malija) have been completed. Obtained data show similar sense and amount of horizontal displacements. They exhibit general northward movement of sites at the average velocity of 3 mm/yr. This is in accordance with results obtained from other sites of cirkum-Adriatic region, and it confirms the northward movement of the Adriatic microplate towards the "stable" Eurasian plate. In Slovenia, a northward oriented δ_1 tensor have been also obtained from several tens of earthquake fault plane solution. Slight defferences in sense and velocity of displacements among particular sites could be explained by the influence of local structures. In Slovenia, they belong to the Periadriatic dextral shear zone, to the Dinaric dextral shear zone, and to the Transdanubian sinistral shear zone. However, the real dynamics of particular structures, among which some also express co-seismic creep, will be possible to determine only by GPS measurements over a denser network of sites.

1. INTRODUCTION

CERGOP (Central Europe Regional Geodynamic Project) was performed in the years 1994 to 1997, and it was followed by the CERGOP-2/Environment, which lasted from 2003 to 2005. In that time, there were several year long or two-year long GPS campaigns. During the decades that the projects were running, the position of geodetic points was determined by epoch GPS surveys which usually lasted for a week.

The most important result of these campaigns is the data on local vectors and velocities of movement of these points, which is the input data for the geo-kinematic interpretation and stress analysis. In the CERGOP-2, project, the role of permanent stations has increased, and the epoch measurements on points have been delegated to secondary position. Their main function now was the maintaining the continuity of the observations and analysis, as well as coverage in the areas where there are no permanent GPS stations. Emphasized is the role of precise GPS surveys for the elaborating of geologic and geotectonic studies of the larger area of Central Europe and the Mediterranean, as well as the study and observation of movements in smaller areas. More modern methods of movement observation in real-time, frequency analysis and connecting GPS survey data with other sensors are implementing.

The main objective of the CERGOP-2 project is the set-up of interdisciplinary and multipurpose network of survey stations for environmental research in the region of Central Europe – CERGOP-2/Environment. The network consists of permanent GPS stations, which are sending their data into a central base. Along with the permanent stations, we have continued periodical observations on geodynamic points. The purpose of these is the carry-over of CERGOP (1) information and the usefulness of the information collected, as well as connection of permanent stations with their area and land coverage where the permanent stations have not yet been established. Slovenia is among those areas.

The project contains the data from 30 geodynamic points for the period of 8 to 9 years. 53 permanent stations included in the project have data for every day of the last 4 to 6 years stored. All these stations together form CERGOP (Central Europe geodynamic reference network). At the forming of the project, the leading team developed a plan of establishing permanent GPS stations, which was co-founded by EU. Two of the stations were planed in Slovenia, but that part was never realized.

2. GEODESY

Slovenia took part in the CERGOP-1 project with the epoch data by the point LJUB. The survey was repeated every year from 1994 to 1997. In CERGOP-2, Slovenia participated with permanent station GSR1, which is integrated into the project through EPN (Europen Permanet Network of GPS stations) as well as with geodynamic points which are part of periodic – anual or bi-anual survey. In the year 1999, the point LEND– Lendavske gorice, and in year 2001 the pont TOSK – Toško čelo was also included. The later point was some time considered as a location for the permanent station. However, these two point are not included in later surveys.

Table 1: Review of surveys for the period from 1994 to 2005

Year	Station						
	LJUB	BOZI	LEND	MALI	SNEZ	MRZL	TOSK
CERGOP-1							
1994	1						
1995	1						
1996	1						
1997	1						
1999	1	1	1	1			
2001	1	1		1	1	1	1
CERGOP-2							
2003	1	1		1	1	1	
2005	1	1		1	1	1	

Results and data based from other projects can also be of importance for future work on geodynamic projects in Slovenia. They are also interesting for the purpose of processing geodynamic movements of GPS points, especially if they include CERGOP points. One of those projects is AGREF, which includes permanent stations Bovec, Radovljica, Slovenj Gradec and Maribor. AGREF can serve as a model for the shaping of the Slovenian network of geodynamic points, at the same time it presents an opportunity to take advantage of the measurements from the year 1992 forward. Second good possibility is a use of network of permanent GPS stations. This network could also play an important role in the network of geodynamic points for research of geologic dynamies. The SIGNAL network of permanent stations of Slovenia started in 2001 with the station GSR1. More progress took place in 2005 with 14 stations operating at the end of the year. This network is capable to be connected to network of permanent GPS stations in central Europa.

Survey in Slovenia in the year 2005

As in previous years, the survey in Slovenia was done by Faculty of Civil Engineering and Geodesy in Ljubljana. The survey included 5 points: LJUB, BOZI, MALI, SNEZ and MRZL. However, as said before results of measurements on the three sites only are presented on Figure 1.

Table 2. Results of measurements in the year 2005 (data by J. Hefty)

Station	No. of CEGRN epoch	North-south [mm/yr]		East-west [mm/yr]		Height [mm/yr]		Mean velocity [mm/yr]	Azymuth [°]
		velocity	accuracy	velocity	accuracy	velocity	accuracy		
LJUB	8	1.94	±0.33	-0.65	±0.25	-0.37	±1.55	2.05	341.47
BOZI	4	3.07	±0.83	-0.65	±0.63	-2.75	±4.31	3.14	348.05
MALI	4	2.86	±0.86	0.21	±0.66	-3.96	±4.54	2.87	4.10

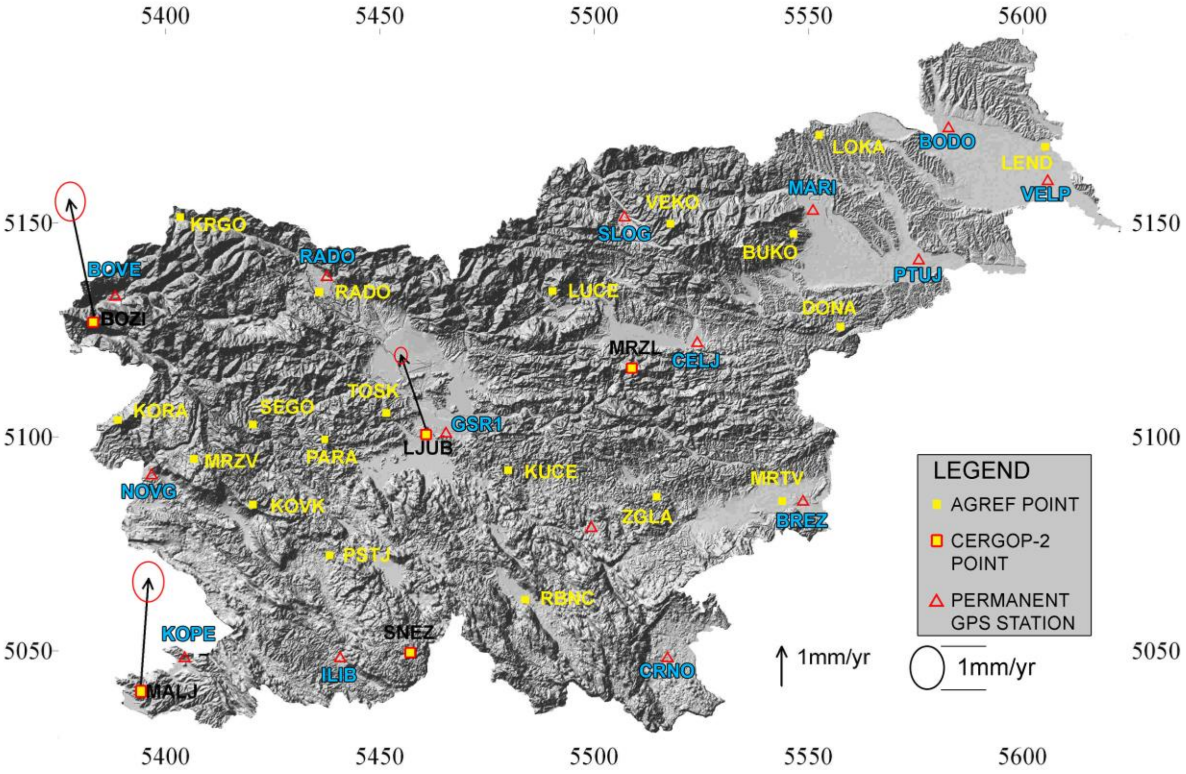

Figure 1. Horizontal velocity map for Slovenia, data obtained by the CERGOP-2 Project data with mean error ellipses (by J. Hafty).

Presented velocities are referred to the ITRF 2000, and they are reduces for APKIM 2000.0 plate motion model. Hower, it should be pointed ant that these values are not definitive because the solution has been not completed by all analysis centres yet.

3. TECTONIC FRAMEWORK OF SLOVENIA

Slovenia lies at the junction of several large geotectonic units: the Alps, the Dinarides and the Pannonian basin (Figure 2).

Following the present plate tectonic concept, the Slovenian territory lies entirely on the norteastern wedge of the Adriatic microplate. This encompasses the Eastern Alps that lie north of the Periadriatic lineament and the Dinarides that lie to the south of it. The Dinarides consist of the Southern Alps, the Internal Dinarides and the External Dinarides. Their boundaries have been mostly determined by the work by L. Placer (1999a). The Adriatic basin, together with its on – shore areas, i.e. the Istrian peninsula, is defined as the Adriatic foreland, which is characterized by tectonically less deformed rocks. Vast areas of central and eastern Slovenia are covered by the Tertiary, mostly Neogene, molasse sediments of the Pannonian basin. However, only the north-easternmost area of Slovenia, called the Mura depression, where these

sediments reach a thickness of several thousand metres, are assigned to the Pannonian basin *sensu stricto* (Poljak, 2000).

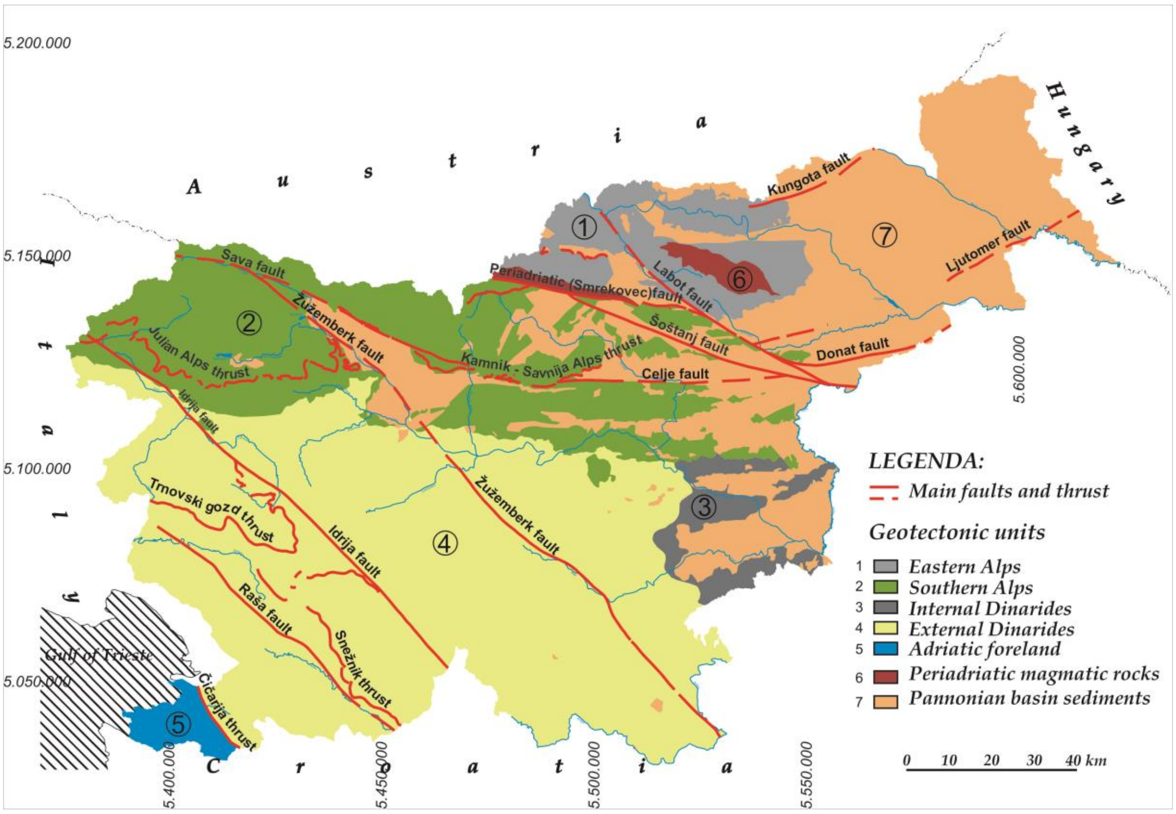

Figure 2. Generalized tectonic map of Slovenia (after Poljak, 2000)

The Alps

***The Eastern Alps* lie north of the Periadriatic lineament. The southern limit of the Eastern Alps in Slovenia is the Ljutomer fault. The Eastern Alps are covered towards the east by the thick sedimentary cover of the Pannonian basin, where they have been located by deep bore holes (Pleničar, 1969).**

The dominant structural pattern of the Eastern Alps is a series of thrust faults and thrust sheets, which are thrust from south to north. The other prominent structural element is a group of faults that accompany the Periadriatic lineament that stretch in a general NW-SE to E-W direction. They all have a strike-slip character with right lateral sense of displacement. The Kungota and Ljutomer faults are two other regional faults of the Eastern Alps. They are, however, covered by the Pannonian basin sediments. These stretch in a SW-NE direction and are reported to be thrust faults with a northward sense of displacement. They supposedly exibit a left - lateral strike character (Pleničar, 1969).

The Dinarides

The Dinarides *sensu lato* include the Southern Alps, the Internal Dinarides and the External Dinarides in Slovenia.

***The Southern Alps* occupy the area to the south of the Periadriatic lineament and encompass the Southern Karavanke Mts., the Julian and Kamnik – Savinja Alps and the Alpine foreland (Slovenian basin).**

The Karavanke Mountains are divided into the northern part, which belongs to the Eastern Alps and the southern part, which is part of the Southern Alps. The northern boundary of the Southern Karavanke Mts. is the Smrekovec fault, which expresses a surface propagation of the Periadriatic lineament from the depth, whilst the southern limit is largely marked by the Sava fault. The Southern Karavanke Mts. truncate to the east under the sediments of the Pannonian basin. The structural built up of the Southern Karavanke Mts. is characterized by a series of thrust faults and thrust sheets with a southward sense of thrusting. The faults belong to several groups, the most prominent of which consists of faults in a general NW-SE direction that mostly join the Sava fault to the south.

The Julian and Kamnik – Savinja Alps lie south of the Mts. Karavanke. Their main structural characteristic is a series of thrusts and thrust sheets with a southward sense of displacement. Their southern boundary is a prominent thrust onto the Slovenian basin area. The Julian Alps are separated laterally from the Kamnik Savinja Alps by the Ljubljana basin. As far as the fault pattern is concerned, there are two most prominent groups of faults, which stretch in SW-NE and NW-SE directions. The first group of faults are prominent in the Julian Alps, where they continue from the External Dinarides. The Idrija fault is a distinct fault of this group. It is a right lateral strike – slip fault. The other NW-SE oriented faults have the same character. The other group of SW-NE direction faults is present in both the Julian and Kamnik-Savinja Alps. They are described to be left lateral strike – slip faults.

The Alpine foreland occupies the most part of the Sava folds, and corresponds mainly to the terrain of the so-called Slovenian basin. The southern boundary of the Slovenian basin as a whole is marked respectively by a W-E trending fault and W-E thrusts. The main structural characteristics of this area are folds that stretch in a W-E direction. The dominant faults of this whole area are those in a SW-NE and a NW-SE direction, which stretch in this direction from the Internal and External Dinarides. Minor faults in a general W-E and N-S direction are superimposed over these.

The Internal Dinarides **occupy a smaller southeastern part of Slovenia. Structurally, the Slovenian Internal Dinarides encompass the southern part of the Sava folds, and reach as far as the Gorjanci Mountains in the south. The boundary between the Internal and the External Dinarides is in Slovenia a transitional one. Further southwest, in neighbouring Croatia, the Internal Dinarides are thrust in a south-westward direction onto the External Dinarides. These are assigned to the so-called Supradinaricum, according to the M. Herak (1986) division of the Dinarides. Besides the W-E to WSW-ENE structures that dominate in the Internal Dinarides of Slovenia, there are also folds, faults and thrust, which stretch in NW-SE direction and these are superimposed by W-E trending structures of the Sava folds.**

The External Dinarides **occupy most part of southern Slovenia. They are generally identical to the Adriatic – Dinaric carbonate platform (Jurkovšek et al., 1996). The most prominent structures of the External Dinarides are folds, faults and thrusts that stretch in NW-SE direction. These are usually described as typical** ***dinaric*** **structures. Faults of this group have mostly strike-slip character with right lateral horizontal displacement. There are some regional faults that stretch from the External Dinarides towards the northwest into the Southern Alps (Idrija, Žužemberk etc.). Tectonic displacements along thrusts are from northeast to southwest. The thrusting of the Southern Alps has influenced the northern part of the External Dinarides. Thus, some structures, particularly reverse faults and thrusts in a general E-W direction, have a southward sense of displacement. The southwestern boundary of the External Dinarides towards the Adriatic foreland is represented by the thrusted and imbricated structure of the Čičarija Mountains onto the coastal flysch area. Recent studies have, however, shown that this area is predominantly built up of various types of folds that are generally overturned and only slightly thrust towards the southwest (Poljak and Rižnar, 1996). In the southeastern part of Slovenian External Dinarides, there is a distinct morphological pattern of structures that belongs to the Transdanubian and Mid-Hungarian zone. This consists of a set of regional faults and folds that strech in general E-W do ESE – WNW direction. Faults are mostly left – lateral strike slip ones, since the folds have supposedly a** ***pop-up*** **character (Tomljenović and Csontos, 2002).**

The Adriatic foreland

This region is related to the less deformed Istrian platform which is a part of the whole Adriatic – Dinaric platform. The Slovenian part of the Istrian platform is built up of sub-horizontal Eocene flysch deposits with one structural anomaly. This is a structural dome at the town of Izola, which consists of Palaeocene limestones. It was formed as a compressional structure in front of the regional Čičarija thrust (Placer, 2005).

The Pannonian basin

The Tertiary sediments of the Pannonian basin occupy eastern Slovenia, but they also reach as far westward as its central part, where they overly the Alps and Dinarides. The Pannonian basin of north-eastern Slovenia *sensu stricto* consists of the so-called Mura and Drava depressions, where sediments reach a thickness up to several thousand metres.

In this area, there were determined several sinforms and antiforms of the Tertiary basement, which are NW-SE oriented (Vončina, 1965). These also include a part of the Tertiary sedimentary cover. The basement in this area is also fragmented by faults. The dominant group of faults run in a SW-NE direction. The regional faults include the Kungota and Ljutomer faults. It has been proposed that they are both reverse faults with a northward direction of thrusting. The latter also represents the basement boundary between the Eastern Alps to the north and the Southern Alps to the south.

4. SEISMICITY

The seismicity of Slovenia is controlled by the geodynamic setting of the country within three large geotectonic units: the Alps, the Dinarides and the Pannonian basin. It is mainly constrained to the regions where these units are in direct contact. Studies of seismicity of Slovenia (as well as that of neighbouring countries) were based mostly on macroseismic data (Ribarič, 1982). Till late 1980-ies, the number and distribution of seismological stations in Slovenia was too small to allow a reliable estimate of earthquake parameters from instrumental records.

The territory of Slovenia can be considered to be one of moderate seismicity. The oldest event in the catalogue of earthquakes in Slovenia (Ribarič, 1982) dates back to 792, and it is of still-unconfirmed reliability (Cecić and Živčić, 1996). Since then, there has been one event of maximum intensity X MSK, two of intensity IX MSK and 11 that reached the maximum intensity VIII MSK. Only three earthquakes of intensity VIII MSK have occurred in the last 200 years.

The strongest event on the territory of Slovenia happened on 26 March 1511 (Ribarič, 1979). Its exact location and nature, and its possible relation to an almost simultaneous event in Friuli (NE Italy), are still uncertain but most authors connect it with the Idrija fault. It caused extensive damage throughout Slovenia and neighbouring countries. The magnitude M_{LH} of the event as estimated, from its macroseismic effects, is between 6.8 (Živčić and Cecić, 1998) and 7.2 (Ribarič, 1979). The most recent study (Fitzko et al., 2005) supports earlier conclusions by locating

the event on the central segment of the Idrija Fault with magnitude M=6.9. This is the only event of intensity X MSK in Slovenia.

The distribution of the epicentres in Slovenia has a rather smeared pattern. This can partly be attributed to the fact that the majority of epicentres was determined from macroseismic data, so they reflect the surface manifestations of an earthquake rather than its hypocentral position at depth, and are not the best for studying seismotectonic processes, except for very general features. For more detailed mapping of active structures, one should use hypocentral determinations from the dense network of seismic stations which for Slovenia exists only for the few last years, and the data are so far scarce. Epicentres of earthquakes with a magnitude of M_{LH} = 4.5 and larger after 1870 are plotted on Fig. 3. The distribution indicates the existence of several areas of increased seismicity in SW, NW and central Slovenia.

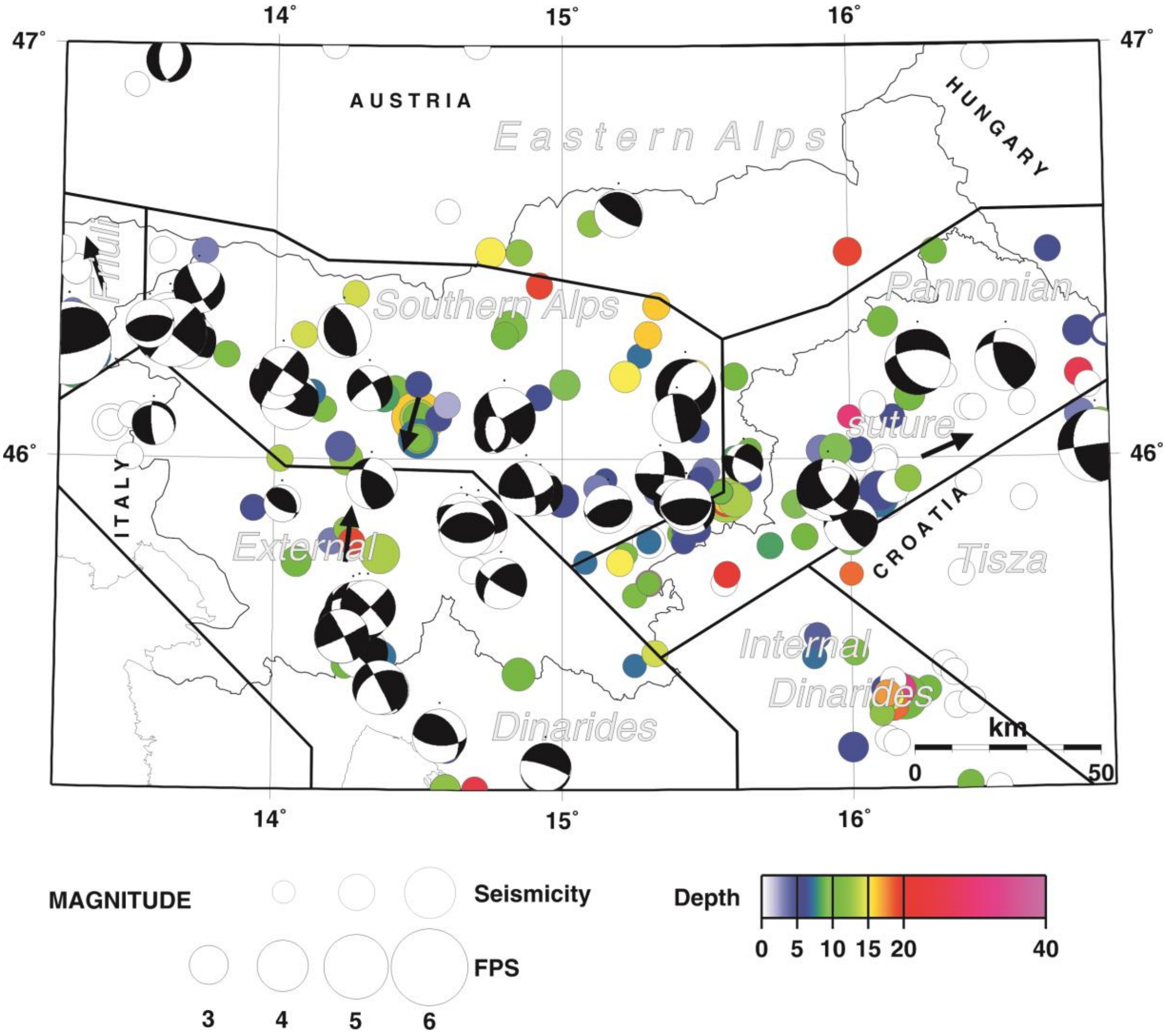

Figure 3. **Seismicity map of Slovenia with focal mechanism and seismotectonic units (modified after Poljak et al., 2000)**

Most of the seismicity in the area is constrained to be located in the upper crust, focal depths of recent events exceeding 15 km occur only in restricted areas. The average depth of all earthquakes in Slovenia is 6.5 km. The depths of stronger earthquakes (M_{LH} > 4.2) occurring in the major part of Slovenia are between 9 and 20 km. This is the case in central and eastern Slovenia, and the south-western part that extends into Croatia. Deeper earthquakes with depths of more than 25 km are probably connected with major faults reaching the basement, presumably separating the larger tectonic units in the region. They occur in the Friuli (Italy) and in the Rijeka (Croatia) region. Hypocentres are also deeper in the Transdanubian range between eastern Slovenia and Croatia.

Only recently, the increased number of instruments and tools for data-processing has allowed detailed seismicity-mapping based on instrumental data. Some distinct lines of hypocentral concentration resulted from the simultaneous inversion for hypocentres and a three-dimensional crustal velocity model (Fig. 3 and 4 in Michelini et al, 1998). The most pronounced are the delineations along the Raša and the Idrija Faults in a NW-SE direction. The hypocentral depth distribution shows a similar pattern, but earthquakes are, on average, deeper than those estimated from macroseismic data for older earthquakes. Another detailed study was performed on the aftershock sequence of Mw=5.6 earthquake of 12 April 1998 in NW Slovenia (Bajc et al., 2001). A subvertical fault striking NW-SE was clearly delineated and consistent with almost pure strike slip earthquake mechanism as well as with finite source modelling. This is so far the only case where an earthquake in Slovenia can be unambiguously attributed to a particular fault.

From the fault plane solutions (FPS), it is evident that the governing stress in the region is approxima tely N-S oriented direction. Under the assumption of uniform stress throughout the region, M. Poljak et al., (2000), have determined the principal stress δ_1 using the method of Gephart and Forsyth (1984). They obtained the azimuth of 6° and dip 8°. Their dip of the least principal stress δ_3 of 5° is consistent with regional strike slip regime. The horizontal stress field in the wider region, as determined from focal mechanisms (Udias and Buforn, 1993) and by modelling (Grünthal and Stromeyer, 1986), has an approximately N-S-oriented maximum principal stress. From the relatively large misfit Poljak et al., (2000), suggested that the stress is not uniform within the region. Inverting for the stress in three separate regions they got better results: the; largest smaller misfit of individual nodal planes was 26 degrees, another four being larger than 10 and the rest are less than 10 degrees. These results suggest that the stress regime within individual seismogenic areas is uniform. The results of stress inversion are given in table 1.

TABLE 3. **Orientations of stress tensors and average misfits for individual seismogenic zones (data from Poljak et al., 2000).**

Area	δ_1 **trend/dip**	δ_2 **trend/dip**	δ_3 **trend/dip**
Southern Alps	**195/9**	**84/67**	**288/21**
External Dinarides	**183/11**	**323/75**	**91/9**
Transdanubian	**67/22**	**309/49**	**172/33**
3 regions together	**6/8**	**223/81**	**97/5**

Probably due to the relatively small magnitude of the earthquakes used, most of the earthquake mechanisms seem to be controlled by local conditions rather than by those prevailing on a regional scale.

5. RECENT GEODYNAMICS

On the basis of tectonic built up and kinematics of structures, Slovenia can be divided into three main areas or zones, regarding its recent dynamics (Figure 4). These generally correspond to the main geotectonic units presented on the Figure 1, as well as to the main seismogenic zones presented on the Figure 3. The units are: the Periadriatic shear zone that stretches in general WNW-ESE direction, the Zagreb or Mid-Hungarian shear and partially transpression zone that stretch in general WSW-ENE direction, and the Dinaric shear zone that stretches in NW-SE direction.

Besides these, the area between the main zones could be determined as an additional sub-zone. It was named by Placer (1999b) the Sava compressive wedge, and it exhibits structural characteristics and dynamics of all main zones, in addition to folding in general E-W direction following by thrusting towards the north and south.

The Periadriatic shear zone encompasses wide structural belt between the Periadriatic lineament on the north, together with the Ljutomer fault as its northeastward continuation, and the Sava fault on the south. Within this belt, there are some other distinct faults as the Šoštanj and Donat ones. The dynamics of the zone also affects naigbouring areas as the Northern Karavanke thrust sheet and northern part of the Julian Alps. Obliquely to the Periadriatic zone, there is the Labot dextral strike-slip fault that joins the Sava fault on the south. The Periadriatic zone is characterized by, geologically evident, right – lateral horizontal displacements (Placer, 1996) that alternate with transpressive vertical extrusion.

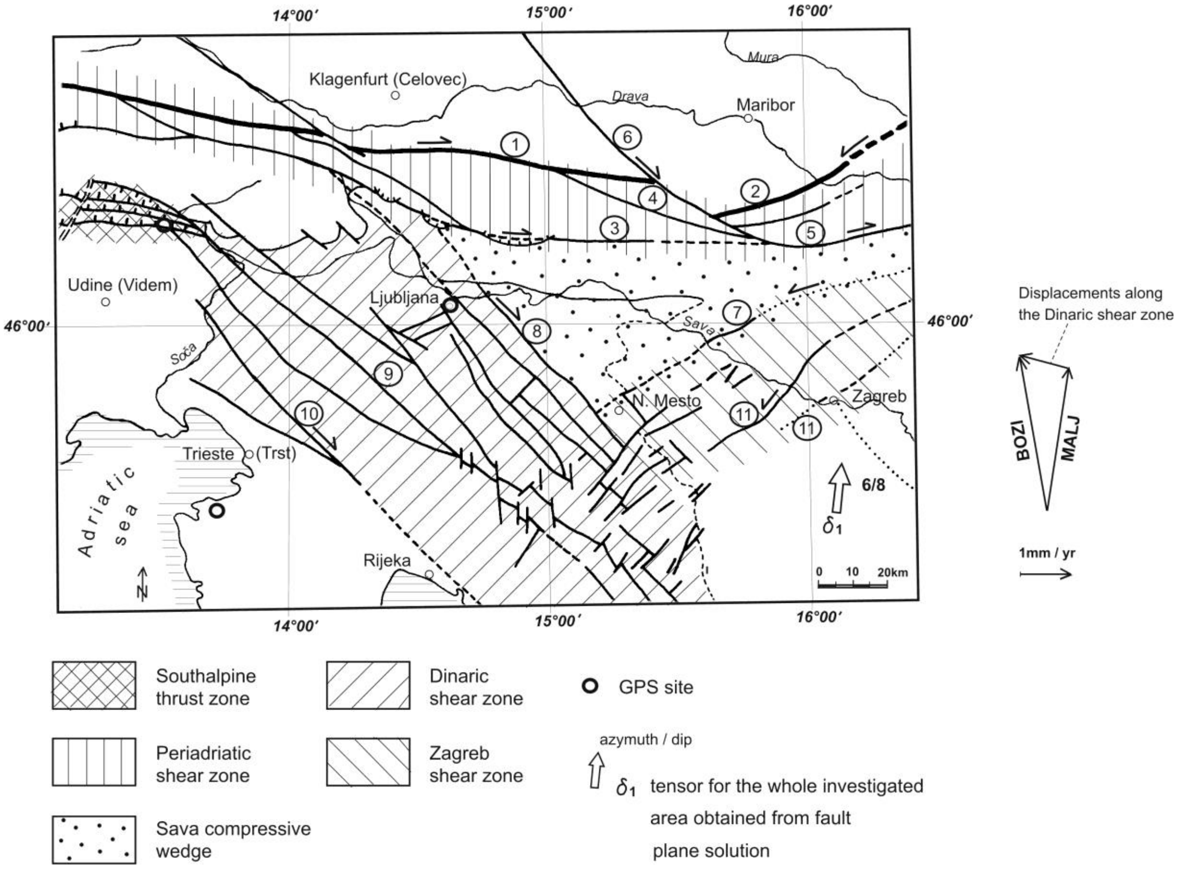

Figure 4. **Recent gedynamic map of the investigated area. Faults: 1. Smrekovec (Periadriatic lineament), 2. Ljutomer, 3. Sava, 4. Šoštanj, 5. Donat, 6. Labot, 7. Orlica, 8. Stična, 9. Idrija, 10. Raša, 11. Zagreb and 12. Sv. Jana (modified after Placer, 1999b)**

The Zagreb or Mid-Hungarian zone encompasses the area between the Orlica fault on the north and the Zagreb – Sv. Jana fault on the south. It is, otherwise, a part of the wide Transdanubian Range. Its kinematics manifests as a left-lateral horizontal displacements along the faults in SW-NE direction, tranpressive vertical exstrusion, and foldings in the some longitudinal direction.

The Dinaric shear zone encompasses a wide belt between the Raša fault on the southwest and the Stična fault on the northeast. It generally corresponds to the geotectonic unit of the External Dinarides. The whole zone consists of sets of faults that stretch in NW-SE direction. They exibit right-lateral horizontal displacements that also cause some transpressive vertical extrusion ups. The most prominent structure here is the Idrija fault, that consists of a broad fault zone. Dinaric longitudinal faults that lie northeast of the Idrija faults stretch into the Southern Alp, since the faults on the southwestern side of the Idrija fault do not crosscut the Southalpine thrust zone.

The GPS permanent network of the CERGOP project in Slovenia consists of five points. They are located in different geotectonic and geodynamic areas (Figure 1). The Božica (BOZI) site is located in the Southalpine thrust front south of the Idrija fault. The Ljubljana (LJUB) and Snežnik (SNWZ) sites are within the Dinaric zone. The Malija (MALJ) site is in the Adriatic foreland, and the Mrzlica (MRZL) site is between the Periadriatic and Zagreb zone, to be more precise in the area of the Sava compressive wedge.

As it was stated in the introductory chapter, measurements results of the CERGOP campaign for Slovenia were obtained for the three sites only (Ljubljana, Božica and Malija). They are located in the Dinaric shear zone, whereas the Božica site could be influenced by the Southalpine thrust front, and the Ljubljana site by the Periadriatic shear zone. However, in spite of that, all the displacement vectors are almost the same, regarding their displacement rates and directions. That could mean that the displacement of the whole region is constant without significant influence of local structures. These results are in accordance with the recent dynamics on the regional scale (CERGOP Horizontal Velocity Map), to be more precise, with the northward movement of the Nubian plate that also causes the northward displacement of the Adriatic or Apulian microplate (Barrier et al., 2000). Regarding Slovenia itself, the results of CERGOP compaign are also in accordance with results obtained by some other projects that confirm the northward displacement of the Adriatic microplate with its simultaneous counterclock-wise rotation (Weber et al., 2005). Furthermore, б$_1$ tensor obtained from earthquakes focal mechanismis for the whole investigated region is generally N-S oriented, what support results obtained by the GPS measurements. However, one should keep in mind, that the period of measurements within the CERGOP project is to short (1999-2005), with the exception of the LJUB site (1994-2005) for a reliable interpretation of results. Finally, the density of the sites is to poore what does not enable a reliable interpretation of influences of local structures dynamics to the cummulative value at particular sitees.

However, an attempt could be made in order to interpret some differences of obtained values. Thus, the difference in displacement rates and directions between the Božica and Malija sites vectors could be explained by cumulative dextral displacements along faults of the Dinaric shear zone. The displacements could also be co-seismic ones, and related to a particular seismic event, as for instance to the earthquakes from the years 1998 and 2004 at the Idrija fault zone (Zupančič et al., 2000; Vidrih, 2005). On the other hand, we are aware of the fact that the measurements errors are larger than the measured differences among particular sites. Thus, the vector analysis presented on the Figure 4 can not reflect the real dynamics, however, we believe that such an analysis should be applied in interpretation of future denser regional and local GPS networks in Slovenia.

6. CONCLUSION

The CERGOP Project provides excellent data on recent dynamics of the whole region covered by GPS sites. Because of the consistence and comparability of these data, it is possible to observe recent dynamics of the large Eurasian and African (Nubian) plates together with a number of smaller lithosperic fragment situated in between (Adria, Iberia, Corso-Sardinia etc.). Thus, one of the final products of the project should be the elaboration of a gedynamic map of the whole CERGOP Environment area. This map should also includes the other complementary data as tectonics, seismicity, stress field etc.

On the other hand, geodynamics of particular smaller areas, that is determined by the geometry and kinematics of local tectonic structures, should be analysed on the basis of denser CERGOP GPS sites including other local national and international networks. Therefore, one of the gools of the expected extension of the CERGOP Project should be the unification of all of these data. This would enable a reliable and accurate interpretation of recent and even future dynamics of regional geotectonic units as well as the dynamics of local tectonic structures.

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