DATA ACQUISITION FOR THE SWISS ATLAS OF PHYSICAL PROPERTIES OF ROCKS

MULTI-YEARS PROGRAM SAPHYR (E. KISSLING AND J.-P. BURG).

Luigi Burlini,

Geological Insitute, ETH Zentrum

Leonhardstrasse, 19

CH-8092 Zurich

Burlini@erdw.ethz.ch

Klaus Holliger

Institute of Geophysics, University of Lausanne

Amphipole - UNIL SORGE

CH-1015 Lausanne
Klaus.Holliger@unil.ch

ABSTRACT

With the multi year program **SAPHYR** we propose to upgrade and extend the existing data-bases on different type of physical properties of rocks in a dynamic platform that can serve to industry, society and scientific world.

Here we report the advancement of the inventory of existing data for the SAPHYR multiyear program, especially on the seismic properties of rocks from samples from Switzerland.

1.1 THE SAPHYR MULTIYEAR PROGRAM

Physical properties of rocks are key parameters for several disciplines spanning from oil industry to engineering to geophysics, petrology, structural geology and water resources. They are therefore useful to several scientific disciplines as well as to industry and society.
The long term aim is to digitize all existing data and to link them using a geographical frame (GIS), so that data can be ready accessible.
Where data are less abundant we will promote campaigns of measurements on rocks samples collected during previous or this project.
The resultant maps will be integrated in the Atlas of Switzerland.

The physical properties we will focus primarily are:
1) density and porosity
2) seismic properties

3) Magnetic properties and their anisotropy
4) Thermal properties
5) Gamma radiation, heat production
6) Permeability
7) Electrical properties

2 RESULTS ACHIEVED

2.1 THE INVENTORY

Data from literature has been collected extensively for seismic properties and partially for the other physical properties. The complete list is given in the References at the end of the report.

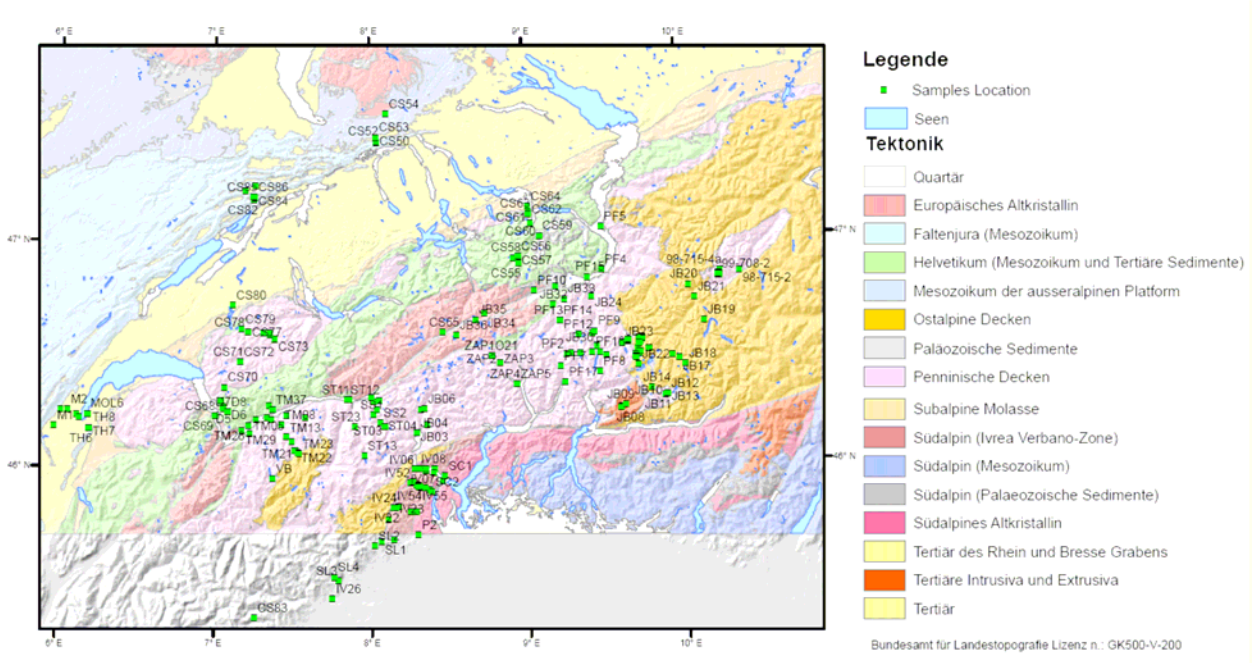

Figure. 1. Geological map of Switzerland with location of samples where laboratory Vp measurements are available. (Base map courtesy of A. Pfiffner. Compilation of A. Zappone and S.Wölbier)

2.2 ACCESSIBILITY OF THE DATA

Since data will be collected from different sources, some of which are not public, the data will be of limited accessibility from the users. In practice the users will be able to access only the elaboration of the original data and to access the source of the data, so that in case of necessity, the original data can be directly requested to the source.

4 classes of data has been suggested, corresponding to 4 levels of accessibility:

Level 1) From international literature = Fully accessible

Level 2) From Thesis and published reports etc. of public offices = Restricted acc.

Level 3) From internal reports of semiprivate offices, or unpublished data of ongoing research = For compilation maps. Available under conditions

Level 4) From industry and private offices = For compilation maps. Not Available, but source reported.

2.3 CAMPAIGN OF NEW DATA

Since from Figure 1 is clear that not all the lithologies and the area are equally covered by sampling, it is suggested that a new campaign of sampling with the aim of new measurements should be carried out in the summer 2008. On each sample the following properties should be equally measured:

- Seismic properties
- Thermal conductivity
- Density
- Porosity
- Chemical and modal composition, fabric, SPO, LPO…
- Electrical conductivity
- AMS

2.4 EXPECTED OUTPUT

The first output will be a map of Switzerland with sample location, a map with contoured values of Vp and a map of Vs extrapolated to room conditions from the high pressure measurements (matrix or crack free properties). The values will be with reported as contours or color coded. We expect to publish the results on the Atlas of Switzerland, hopefully by the end of 2008. The data will be only those compiled from the literature.

Other output will regards the other physical rock properties, on which we will concentrate on the next future.

2.5 MILESTONE

Here the main milestones for the year 2008:

Nov.07 – Jul.08 Finish to collect existing data (e.g. NAGRA, State offices, Private companies)

Jan.08 – Aug.08 First draft of GIS

Apr.08 – Oct.08 First draft of 2D Atlas

Jun.08 – Sep.08 Campaign of new sampling

Oct.08 – Oct.09 New measures (Vp, thermal etc)

Oct.09 – Apr.10 Final GIS, Final 2D Atlas

May10 – Aug.10 Final report.

2.6 REFERENCES

2.6.1 Seismic and elastic properties (and density measurements)

Barruol, G., Deschamps, A. and O. Coutant. 2004. Mapping upper mantle anisotropy beneath SE France by SKS splitting indicates Neogene asthenospheric flow induced by Apenninic slab roll-back and deflected by the deep Alpine roots. *Tectonophysics*, 394, 125 -138.

Barruol, G. and H. Kern. 1996. Seismic anisotropy and shear-wave splitting in lower-crustal and upper-mantle rocks from the Ivrea Zone experimental and calculated data. *Physics of the Earth and Planetary Science Letters,* 95, 175 – 194.

Berckhemer, H., Auer, F. and J. Drisler. 1979. High temperature anelasticity and elasticity of mantle peridotite. *Physics of the Earth and Planetary Science Letters*, 20, 48 – 59.

Bohlen, T., Rabbel, W., Weiss, T., Siegesmund, S. and M. Pohl. 1999. Recovering Shear-wave Anisotropy of the Lower Crust: The Influence of Systematic Errors on Travel-time Inversion. *Pure and Applied Geophysics,* 156*,* 123 – 138.

Burke, M. M. and D. Fountain. 1990. Seismic properties of rocks from an exposure of extended continental crust-new laboratory measurements from the Ivrea Zone. *Tectonophysics,* 182, 119 – 146.

Burlini, L., Marquer, D., Challendes, N., Mazzola, S. and Zangarini, N. 1998. Seismic properties of highly strained marbles from the Splügenpass, central Alps. *Journal of Structural Geology,* 20, 277 – 292.

Burlini, L. and D. Fountain. 1993. Seismic anisotropy of metapelites from the Ivrea-Verbano zone and Serie dei Laghi (northern Italy). *Physics of the Earth and Planetary Science Letters,* 78, 301 – 317.

Fountain, D. 1976. The Ivrea-Verbano and Stronaseneri zones, northern Italy: a Cross-section of the continental crust – new evidence from seismic velocities of rock samples. *Tectonophysics,* 33, 145 – 165.

Hölker, A. B. 2001. *Seismic structure and response of ocean-continent transition zones in magma-poor rifted continental margins*. Ph.D. Thesis, ETH, 133pp.

Kampfmann, W. and H. Berckhemer. 1985. High temperature experiments on the elastic and anelastic behavior of magmatic rocks. *Physics of the Earth and Planetary Interiors,* 40, 223 – 247.

Kern, H. 1978. The effect of high temperature and high confining pressure on compressional wave velocities in quartz-bearing and quartz-free igneous and metamorphic rocks. *Tectonophysics,* 44, 185 – 203.

Kern, H. 1993a. Physical properties of crustal and upper mantle rocks with regards to the lithosphere dynamics and high pressure mineralogy. *Physics of the Earth and Planetary Interiors,* 79, 113 – 136.

Kern, H. 1993b. P- and S-wave anisotropy and shear-wave splitting at pressure and temperature in possible mantle rocks and their relation to the rock fabric. *Physics of the Earth and Planetary Interiors,* 78, 245 – 256.

Kern, H. and A. Richter. 1981. Temperature derivatives of compressional and shear wave velocities in crustal and mantle rocks at 6 kbar confining pressure. *Journal of Geophysics,* 49, 47 – 56.

Kern, H., Burlini, L. and I. V. Aschepkov. 1996. Fabric-related seismic anisotropy in upper-mantle xenoliths: evidence from measurements and calculations. *Physics of the Earth and Planetary Interiors,* 95, 195 – 209.

Khazanedhari, J., Rutter, E., Casey, M. and L. Burlini. 1998. The role of crystallographic fabric in the generation of seismic anisotropy and reflectivity of high strain zones in calcite rocks. *Journal of Structural Geology,* 20, 293 – 299.

Khazanedhari, J., Rutter, E. and K. Brodie. 2000. High-pressure-high-temperature seismic velocity structure of the midcrustal and lower crustal rocks of the Ivrea-Verbano zone and Serie dei Laghi, NW Italy. *Geophysical Research Letters,* 105, 13,843 – 13,858.

Mazzoli, C., Sassi, R. and L. Burlini. 2002. Experimental study of the seismic properties of the Eastern Alps (Italy) along the Aurina–Tures–Badia Valleys transect. *Tectonophysics,* 354, 179 – 194.

Musacchio, G., Zappone, A., Cassinis, R. and S. Scarascia. 1998. Petrographic interpretation of a complex seismic crust–mantle transition in the central-eastern Alps. *Tectonophysics,* 294, 75 – 88.

Peselnick, L., Nicolas, A. and Stevenson, P.R.. 1974. Velocity anisotropy in a mantle peridotite from the Ivrea Zone: application to upper mantle anisotropy. Journal of Geophysical Research, 79, 1175-1182.

Pera, E. and L. Burlini, 2001. Elastic properties of selected Italian marbles. In: *Understanding and Managing Stone Decay,* ed. R. Prikryl and H. Viles, pp. 261 – 272.

Pros, Z., Lokajicek, T., Prikryl, R. and K. Klima. 2003. Direct measurement of 3D elastic anisotropy on rocks from the Ivrea zone (Southern Alps, NW Italy). *Tectonophysics,* 370, 31 – 47.

Rabbel, W., Siegesmund, S., Weiss, T., Pohl, M. and T. Bohlen. 1998. Shear wave anisotropy of laminated lower crust beneath Urach (SW Germany): a comparison with xenoliths and with exposed lower crustal sections. *Tectonophysics,* 298, 337 – 356.

Siegesmund, S., Takeshita, T. and H. Kern. 1988. Anisotropy of *VP* and *VI* in an amphibolite of the deeper crust and its relationship to the mineralogical, microstructural and textural characteristics of the rock. *Tectonophysics,* 157, 25 – 38.

Siegesmund, S., Kern, H. and A. Vollbrecht. 1991. The effect of oriented microcracks on seismic velocities in an ultramylonite. *Tectonophysics,* 186, 241 – 251.

Siegesmund, S. and H. Kern. 1990. Velocity anisotropy and shear-wave splitting in rocks from the mylonite belt along the Insubric Line (Ivrea Zone, Italy). *Earth and Planetary Science Letters,* 99, 29 – 47.

Siegesmund, S. and J. H. Kruhl. 1991. The effect of plagioclase textures on velocity anisotropy and shear wave splitting at deeper crustal levels. *Tectonophysics,* 191, 147 – 154.

Siegesmund, S. and A. Vollbrecht. 1991. Complete seismic properties obtained from microcrack fabrics and textures in an amphibolite from the Ivrea zone, Western Alps, Italy. *Tectonophysics,* 199, 13 – 24.

Ullemeyer, K., Siegesmund, S., Rasolofosaon, P. and J. Behrmann. 2006. Experimental and texture-derived P-wave anisotropy of principal rocks from the TRANSALP traverse: An aid for the interpretation of seismic field data. *Tectonophysics,* 414, 97 – 116.

Zappone, A., Sciesa, E. and E. Rutter. 1996. *Geol. Insubr.* 1, 7 – 16.

2.6.2 Thermal conductivity, electrical and mechanical properties

Rybach, L. and M. Pfister. 1994. How to predict rock temperatures for deep Alpine tunnels. *Journal of Applied Geophysics,* 31, 26 – 270.

Rybach, L., Werner, D., Mueller, S. and G. Berset. 1977. Heat flow, heat production and crustal dynamics in the central Alps, Switzerland. *Tectonophysics,* 41, 113 – 126.

Schärli, U. and L. Rybach. 1984. On the thermal conductivity of low-porosity crystalline rocks. *Tectonophysics,* 103, 307 – 313.

Surma, F. and Y. Geraud. 2003. Porosity and Thermal Conductivity of the Soultz-sous-Forets Granite. *Pure and Applied Geophysics,* 160, 1125 – 1136.

2.6.3 Magnetic susceptibility

Heller, F. 1973. Magnetic anisotropy of granitic rocks of the Bergell Massif (Switzerland). *Earth and Planetary Science Letters,* 20, 180 – 188.

Ihmlé, P. F. 1989. *Magnetic Anisotropy and Deformation in the Morcles Nappe, Swiss Alps.* Diploma Thesis, ETH, pp96.

Rochette, P. 1987. Metamorphic control of the magnetic mineralogy of black shales in the Swiss Alps: toward the use of "magnetic isograde". *Earth and Planetary Science*

Letters, 84, 446 – 456.