

## Valais (Rhone valley, Switzerland)

Situation of the valley



Valais in the area of the city of Monthey

Upper Valais in the area of the city of Brig



### State of the instrumentation and measurements in the valley at the beginning of the project

The Valais is characterised by a permanent strong motion network, but with most of the stations installed on rock. Some geotechnical and geophysical investigations had already been done in several places before the project. But the Valais is very long valley and huge differences are observed from the upper part to the end of

the valley, with sediment thickness varying from about 100 to 1000 m. Therefore, local investigations are needed to perform site effect studies.

### **Instrumentation and measurements realised in the valleys during the project**

The project SISMOVALP allowed the installation of pairs of strong motion instruments in Monthey and Sion, with one station on sediments and one station on bedrock. The field surveys included noise measurements (H/V and Arrays) and SASW measurements to better define the valley geometry and the characteristics of the different types of sediments.

### **Results of the work done in the valley**

The CREALP has produced a mapping (scale 1:25000) of the soil classes according to the Swiss code SIA 261. These maps cover the whole Rhone valley, between Brig and the Lemman lake, which concerns 65% of the population and industry of the Valais. The soil classes were determined using existing documents such as geological maps, boreholes, seismic profiles and gravimetric studies. These maps make it easier to apply the code, in cases where no spectral microzonation study has been performed. CREALP has organised the final Sismovalp meeting, which took place in Martigny (Valais, Switzerland), in October 2006, during a public exhibition about earthquakes. Public conferences have presented the main results of the Sismovalp project to the population and authorities.

The main task accomplished during the first year was to carry out and finalise the spectral microzonation of the area of Monthey (in collaboration with Tissières SA). RIC has contributed (in collaboration with LGIT) to the development of a new version of the 2D Aki-Larner simulation program. This version now accounts for the non-linear behaviour of materials, using the linear-equivalent approach. This program is now working and being intensively tested on theoretical models as well as on real valley profiles in the upper Valais area (Brig and Visp). The program has been first applied for the microzonation of Brig and Visp. It fills a gap in the 2D modelling tools available for site effect estimation, which is crucial in the case of 2D alpine valleys such as the Valais for example. RIC is work-package leader for the WP04 (Generic alpine valley configurations). In this framework, RIC co-ordinates the work between all the WP04 participants. RIC has gathered the valley configurations sent by all participants, in order to send them as basis for the choice of some common valley configuration for the benchmark simulations carried out by WP06. RIC has finalised the questionnaire about the geological configuration and history of our valleys, and sent it to all participants. RIC has collected the answers to this questionnaire and drawn a synthesis based on all answers and present a global comparison showing the similarities and major differences of the valley profiles. Furthermore, Vs velocity profiles were collected for the pilot valleys. All the data and profiles for all valleys have been collected by RIC and gathered to be included in the final Sismovalp CD-Rom. RIC has participated in the organisation of the final meeting and associated conferences, in Martigny 2006.

In the frame of the SISMOVALP Project, the Swiss Seismological Service (SED) has performed field surveys, modelling and the computation of response spectra for sites in the Rhone Valley (Figure 1). The project is closely related to the SNF project SHAKE-VAL ("Earthquake shaking in Alpine valleys") that will be finalised by the end of 2007. Observed ground motion recordings from the SED network during the past years were provided to the project partners and were included in the project database. The project SISMOVALP allowed the installation of pairs of strong motion instruments in Monthey and Sion, with one station on sediments and one station on bedrock. The field surveys included noise measurements (H/V and Arrays) to better define the valley geometry and the characteristics of the different types of sediments. A sand layer observed in many places in the Rhone valley is the most critical ground condition in addition to some alluvial cones. Such sites will be the places of severe ground shaking and liquefaction in future earthquakes. The findings and conclusions from the field measurements are supported by our historical research performed in the frame of a project related to the analysis of past large earthquakes in Switzerland (SNF project "The history of strong earthquakes in Switzerland"). The information from the field investigations allowed us to build new 2D and 3D models of the valley; they were used as input for numerical simulation of the ground response with different numerical codes, using the finite differences method (in 2D and 3D) and boundary element method (2D). The results obtained from 2D modelling were used to estimate the local hazard at different sites in the valley. Related results are compared with the guidelines of the Swiss building code SIA261 and the European reference spectra in EC8. Two strategies were selected for the computation of the local hazard in order to illustrate different types of procedures and related uncertainties. It is recognised that

existing reference spectra might be exceeded by the local response inside the valleys for a return period of 475 years.

### **List of references presenting the results**

- CREALP (2004). Microzonage sismique de la vallée du Rhône entre Brig et le Léman. Cartographie 1:25'000 des sols de fondation, Selon classification de la norme SIA 261. Rapport N° Crealp/04.03.
- Lacave and Koller (2007). Microzonation of the city of visp (switzerland) using a 2d equivalent linear approach (), 4th ICEGE, Thessaloniki.
- Lacave C. and F. Hollender (2006). Ground motion simulation on a 2D profile across the Grenoble basin using the Aki-Larner discrete wave-number method. 3<sup>rd</sup> International Symposium on the Effects of Surface Geology on Seismic Motion. Grenoble, France, 30 August-1 September 2006, LCPC, paper n°14 (Vol 1).
- Lacave C. and F. Lemeille (2006). Seismic hazard and alpine valley response analysis: generic valley configuration.. First European Conference on Earthquake Engineering and Seismology, 3-8 September 2006, Geneva, Switzerland, paper n°1.
- Roten D., D. Faeh and D. Giardini (2006). Site effects in the Rhône valley analysed from ambient noise, local earthquakes and numerical simulations. 3<sup>rd</sup> International Symposium on the Effects of Surface Geology on Seismic Motion. Grenoble, France, 30 August-1 September 2006, LCPC, paper n°92 (Vol 1).
- Fäh D., Havenith H.-B., Roten D., Alvarez S. and Giardini D. (2007). Site Effects in the Rhone Valley, Switzerland: Measurements, Observations, Modelling and Verification of the Building Code Spectra. Final Report Swiss Seismological Service ETH Zurich.