VEÐURSTOFA ÍSLANDS

Report
03031

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PREPARED – Management and resource usage summary

First 6 months: February 1 - July 31, 2003

VÍ-JA04
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Note:
This report has 14 annexes. They can be found on the open PREPARED website - http://hraun.vedur.is/ja/prepared/, except annexes V, VII, VIII and XI that have been set up on the closed PREPARED website - http://hraun.vedur.is/ja/prepared/closed/.

September 22, 2003

1.1 Objectives of the reporting period and summary

The central objective of the project is to apply large amount of geophysical and geological observations related to the two large year 2000 earthquakes in South Iceland to develop technology for improving earthquake preparedness and mitigating risk. Although the project has a central role in evaluating the observations of these earthquakes, much work had already been carried out before in data retrieval and evaluations for the benefit of the project, and the project is a continuation of such work. It is also a continuation of earlier research projects in the same field.

16 European scientific institutions are partners in this project. 11 of these were partners in earlier earthquake prediction research projects in Iceland supported by EC (PRENLAB, PRENLAB-2, SMSITES and RETINA). The others are new partners in this field, added as they can provide significant contribution to various workpackages of the project. Most of the workpackages of the project are carried out in cooperation of two or more partners.

The start date of the project was February 1st, 2003. All the partners attended a kick-off meeting in Reykjavík on February 24-26 to evaluate the state of the research and to organize work within the 25 workpackages. A homepage for the project was also set up in February to tie this multidisciplinary project together and to provide current information of the progress to EC and other users of the results.

During this first part of the project much work has been carried out in retrieving and further evaluation of seismic data which are basic for many partners and workpackages in the project. A dataset of 170.000 earthquakes with high level and qualified information for the period 1991-2000 has been prepared and is being made available for the partners of the project. This dataset is much more elaborated than the regular catalogue. It contains information on refined and manually constrained locations, fault plane solutions as well as two types of magnitudes, moment magnitudes and local scale magnitudes. The time period 1991-1995 as well as 1999-2000 were made available before the end of July 2003, and the remaining data, i.e. 1996-1998 are being made ready during August-September. This dataset is of basic significance for the majority of the workpackages, especially those dealing with seismic patterns in time and space as well as for fault and stress mapping at depth.

In other cases data were ready for application, like much of the geological data used for mapping of surface faults and other surface effects as well as for analyzing paleo-stress fields. However, also this first half year has been used for collecting complementary geological data in some cases.

The project is closely linked to earlier PRENLAB and PRENLAB-2 projects as well as to the RETINA project and the SMSITES project (EC projects). Significant modelling work has already been carried out during this first part based on constraining the models of these projects in light of the year 2000 earthquakes.

Much work had already been carried out before the start of the project in studying deformation related to the earthquakes by InSAR and GPS as well as hydrological

changes. Such work is a significant basis for the PREPARED project and a list of reports of such related work is attached in the annexes to this report.

1.2 Scientific/Technical progress made in different workpackages according to the planned time schedule

The progress of the project has generally been as planned, i.e. on schedule. In a few cases the order of tasks has been changed within workpackages for practical reasons. Table 1 is planned/executed efforts by workpackages. Table 2 and Table 3 show comparison between planned and used manpower. In the following subsections the progress of various WP's is summarized. They are all on schedule unless explained in the text.

1.2.1 WP1 - Coordination. Scientific coordination and management of the project is in the hands of IMOR and has been as planned in the Description of work. (For more details see Annex I – Icelandic Meteorological Office).

1.2.2 WP2 - Analysis of multiparameter geophysical data approaching the June 2000 earthquakes, assessing state of stress. Lead contractor IMOR. Work has been ongoing during all the period. More work has been carried out than planned. The main work during the period was to refine, evaluate further and organize a dataset of 170.000 micro-earthquakes of basic significance for several partners of the project. The work on this enormous amount of data showed to be more than expected, but has now come to a final stage, and provision of this well revised and qualified database has started. (For more details see Annex I – Icelandic Meteorological Office).

1.2.2.1 WP2.1 - Pattern search in multi-parameter seismic data. The WP is led by CAU. The work has had a good start by adaption and enhancement of necessary software, and first test runs for search of patterns in the data. This is a preparation for running the total micro-earthquake database since 1991, which gradually is being made available, during September at latest. (For more details see Annex XII – University of Kiel).

1.2.2.2 WP2.2 - Possible precursory seismic quiescence and b-value changes. The WP which is led by WAPMERR has had a good start. Significant analysis of the database has been carried out, limited though by the fact that only half of the needed database was completed and available for application during the first 6 months of the project. (For more details see Annex XIII – World Agency of Planetary Monitoring and Earthquake Risk Reduction).

1.2.2.3 WP2.3 - Long-term deformation in the South Iceland seismic zone inferred by joint interpretation of GPS, InSAR and borehole strain data. Lead contractor is NVI. Reanalysis of GPS data prior to the earthquakes has started in cooperation with CNRS-UMR 5562. Repeated GPS measurements have been carried out. (For more details see Annex IV – Nordic Volcanological Institute).

1.2.2.4 WP2.4 - Space and time variations in crustal stress using micro-earthquake source information. Lead contractor UU. Algorithms and technique for stress tensor calculations have been prepared to be applied when the total dataset of micro-earthquakes of the SIL system has been reevaluated, i.e. within a couple of weeks. Also it has been studied how precise relative location of earthquakes can be applied when evaluating the stress tensor. The same is true for the pattern analysis by the SAG method. Necessary methodological development has taken place. (For more details see Annex II – Uppsala University).

1.2.2.5 - Using shear-wave splitting above small earthquakes to monitor stress in SISZ. Lead contractor UEDIN. Monitoring of shear-wave splitting in Iceland started under earlier EC projects has continued during the period. Besides this general studies have been carried out during the period on stress relaxation before earthquakes and studies of scatter of shear-wave splitting time delays above earthquake sources. Evaluation of stress-induced SWS changes since 1991 has been waiting for data to be completed. (For more details see Annex III – University of Edinburgh).

1.2.3 WP3 – Short-term changes before large earthquakes, short-term warning algorithms. Lead contractor IMOR. The main work here is multidisciplinary analysis and focussing of results of other WP's, especially the WP2.1-2.5 and WP3.1-3.2. This part naturally waits for such results. The main work done so far is the writing of a report by the contractor on earlier observations of short-term premonitory changes. (For more details see Annex I – Icelandic Meteorological Office).

1.2.3.1 WP3.1 - Foreshocks and development of new warning algorithms. Lead contractor UU. Preparations have been ongoing to recalculate the parameters involved in the earthquake warning algorithms EQWA designed during PRENLAB-2, in light of new data. Also to develop methods for unique determination of fault planes. Such an elimination of the auxiliary plane will possibly help distinguish foreshocks from other seismic activity. (For more details see Annex II – Uppsala University).

1.2.3.2 WP3.2 - Radon anomalies/Development of warning algorithms. Lead contractor SIUI. Time series of radon measurements of various sources in Iceland have been prepared for further analysis and preparation of warning algorithms. (For more details see Annex VI – Science Institute, University of Iceland).

1.2.4. WP4 - A model of the release of the two June 2000 earthquakes based on all available observations. IMOR is lead contractor. Much of the work has been related to evaluation of the multidisciplinary data from various sources applied in this WP. (For more details see Annex I – Icelandic Meteorological Office).

1.2.4.1 WP4.1 - Source mechanisms and fault dimensions of the June 17 and June 21 earthquakes determined from the inversion of teleseismic body waves and from mapping of aftershocks. Lead contractor IMOR. The main part of the work is reevaluation of a large amount of the seismic data and finishing refinement of the methodology to calculate fault plane solutions. Much more work has been involved in this WP than anticipated. The finishing of the inversion of teleseismic data has been delayed, as it is considered significant to finish "precise" mapping of the aftershocks before the teleseismic inversion is finished. (For more details see Annex I – Icelandic Meteorological Office).

1.2.4.2 WP4.2 - Analysis, inversion and estimation of strong ground motion data from extended earthquake fault models of the two June 2000 Icelandic events. Lead contractor UNIVTS.DST. The work during the first 6 months of the project involved assembling the accelerometer waveform database and to obtain the best model of seismic structure of the South Iceland seismic zone, necessary for the inversion. (For more details see Annex XI – University of Trieste).

1.2.4.3 WP4.3 - Surface fractures in the source region of the June 2000 events. Lead contractor SIUI. Faults of about 75% of the SISZ have been mapped by differential GPS and detailed maps of the faults can now be displayed on the map base of the Icelandic Geodetic Survey. (For more details see Annex VI – Science Institute, University of Iceland)

1.2.4.4 WP4.4 - Deformation model for the June 2000 earthquakes from joint intepretation of GPS, InSAR and borehole strain data. Lead contractor NVI. The work is partly a direct continuation of a work started before the start of the project, and is well on schedule. (For more details see Annex IV – Nordic Volcanological Institute).

1.2.5 WP5 - New hazard assessment/New methods for improving assessment of probable earthquake effects. The WP is led by IMOR. The work in this WP involves mainly assembling and merging together the results of WP5.1-5.6 and WP 4.2 as well as the modelling packages. The main work of the contractor so far within this WP is in evaluating and supplying seismic data. (For more details see Annex I – Icelandic Meteorological Office).

1.2.5.1 WP5.1 - Mapping subsurface faults in southwestern Iceland with the micro-earthquakes induced by the June 17 and June 21 earthquakes. Led by IMOR. The work so far involves refinements of methods, group selection and testing, preparing for the mapping work on a large scale. (For more details see Annex I – Icelandic Meteorological Office).

1.2.5.2 WP5.2 - Mapping and interpretation of earthquake rupture in the Reykjanes peninsula and other surface effects there and in the SISZ. Field work is completed and a complete map of primary rupture and secondary effects has been completed. (For more details see Annex IV – Nordic Volcanological Institute).

1.2.5.3. WP5.3 - Study of the strong ground motion, acceleration and intensities of the two large earthquakes. Lead contractor UI. Studies of strong ground motion, including attenuation, based on accelerometer data and questionnaires have been carried out as well as near-source modelling, in accordance with plan. (For more details see Annex XIV – Engineering Research Institute, University of Iceland).

1.2.5.4 WP5.4 - Reevaluation of the historical earthquakes in the light of the new observations. An attenuation formula has been developed based on measurements of the year 2000 activity. Other parts of the WP have been initiated as detailed in the IMOR report. (For more details see Annex I – Icelandic Meteorological Office).

1.2.5.5 WP5.5 - Hydrological changes associated with the June 2000 earthquakes. Lead contractor UIB. The work is well on way including hydrological observations during the 2000 earthquakes, theoretical work on new models of faulting, fluid transport and deformation in the SISZ, as well as planned field work during this summer. (For more details see Annex V – University of Bergen).

1.2.5.6 WP5.6 - Paleo-stress fields and mechanics of faulting. Lead contractor UPMC. The work during the period is in accordance with the plan of fault slip measurements in the field, stress distribution around the June 21 earthquake based on earthquake data and surface deformation of the year 1630 historical earthquake in Iceland. (For more details see Annex VII – Centre National de la Recherche Scientifique, Université Pierre et Marie Curie).

1.2.6 WP6 - Modelling and parameterizing the SW-Iceland earthquake release and deformation processes. Lead contractor IMOR. This WP is mainly based on progress of WP6.1 and 6.2 and of other WP´s parameterizing on basis of various observations of crustal processes. The main work up to now is providing of data and basic information and participation in discussion on modelling efforts. Work has started by CNRS-UMR 5562 to apply 3D finite-element modelling to model the deformation associated with the year 2000 earthquakes. (For more details see Annex I – Icelandic Meteorological Office and Annex X – Centre National de la Recherche Scientifique - Toulouse).

1.2.6.1 WP6.1 - Earthquake probability changes due to stress transfer. Lead contractor GFZ Potsdam. During this first period the contractor has extended his software based on elastic crustal properties, applied in the PRENLAB projects mainly on historical earthquakes, to include also Coulomb stress changes. (For more details see Annex IX – GeoForschungsZentrum Potsdam).

1.2.6.2 WP6.2 - Model stress in the solid matrix and pressures in fluids permeating the crust. Lead contractor DF.UNIBO. All tasks scheduled to start within the first half year have started. The first task "Original mathematical solutions for crack models in trans-tensional environment" has been finished and a paper is in preparation. Minor delay of some tasks due to late acceptance of DF.UNIBO of joint cost research fellowship. (For more details see Annex VIII – University of Bologna).

1.3 Milestones and deliverables obtained

List of deliverables expected during the first half year and how they have been fullfilled:
D1 M01 Kick-off meeting for the project, minutes. Finished in February 2003. (Annex I).
D2 M03 Project website, internal, external. Finished in February 2003. (Annex I).
D7 M01 Sessions at regular project meetings. Finished in February 2003.
D36 M01 Sessions at regular project meetings. Finished in February 2003.
D51 M01 Sessions at regular project meetings. Finished in February 2003.
D74 M01 Sessions at regular project meetings. Finished in February 2003.
D91 M01 Sessions at regular project meetings. Finished in February 2003.

D56 M03 A point source moment tensor solution and source time function for the earthquake of June 17 and June 21, 2000. Expected delay to Month 8.
D65 M06 Map of surface fractures in the eastern source area. Finished in July 2003. (Annex VI). Openly published report in preparation.
D66 M06 Map of faulting during the June 2000 events. Finished in July 2003. Paper in preparation. (Annex VI).
D67 M06 Input into the general modelling of the June 2000 events. Finished during the 1st half year period as input into some of the published modelling. (Annex VI).
D71 M06 Three-dimensional co-seismic displacement field for the June 17 and June 21, 2000 earthquakes. This deliverable has been completed with a paper. (Annex IV).
D98 M06 Original mathematical solutions for crack models in trans-tensional environment. Finished by a report under title: Dislocation models in heteorogeneous media. Paper is in preparation. (Annex VIII).

1.4 Deviations from the work plan or/and time schedule and their impact to the project

There are no deviations from the work plan as a whole. Some tasks have advanced slightly slower than expected while other have advanced faster due to practical order in carrying out the tasks. However, the WP's as a whole are on schedule. Many studies are based on the huge and high level seismic dataset of micro-earthquakes of IMOR from 1991-2000. This dataset includes besides usual information in seismic catalogues to fault plane solutions of all observed earthquakes down to magnitude zero as well as moment magnitudes. It was necessary to reevaluate all this dataset from the routinely evaluated catalogue to a level that can be useful for all workpackages, which are based on seismic data. This reevaluation has now been finished and is gradually being transferred to the users within the project. This was expected and the users have started their work by preparing their software and by test runnings on parts of the data, in preparing the application of the dataset as a whole which will start during the next weeks (Annex I). WP6.2 is on schedule as far as concerns the planned deliverables. However, due to bureaucratic problems at DF. UNIBO selection of candidates for a shared research fellowship was delayed. This may delay other tasks somewhat, and thus must be solved in discussion with EC.

1.5 Communication between partners

The project started with a 3 days kick-off meeting in Reykjavík, with the attendance of all partners, where the state of the research was discussed as well as cooperation, both in the group as a whole as well as cooperation in smaller groups. The center for communication is the PREPARED homepage which was opened in February 2003. An inofficial meeting of the consortium was held.

1.6 Difficulties encountered at management and coordination level and proposed/applied solutions

No problems have occurred.

Workpackage number and name	Month					
	1	2	3	4	5	6
WP 1 Coordination.						
WP 2 Analysis of trends in geophysical data approaching June 2000 earthquakes.						
WP 2.1 Pattern search in multiparameter seismic data, PCA.						
WP 2.2 Analysis of seismic catalogue, homogeneity, quiescence, b-values.						
WP 2.3 Long-term deformation based mainly on GPS, InSAR and strain.						
WP 2.4 Stress changes based on microearthquake sources and from geology.						
WP 2.5 Shear-wave splitting above small earthquakes to monitor stress changes.						
WP 3 Short-term changes before large earthquakes, short-term warning algorithms.						
WP 3.1 Foreshocks. Detailed study and development of new warning algorithms.						
WP 3.2 Radon anomalies. Detailed study and development of warning algorithms.						
WP 4 Detailed model of the two large earthquakes. A group work.						
WP 4.1 Focal mechanism, based on teleseismic and microearthquake information.						
WP 4.2 Inversion of near field strong motion data. Slip distribution.						
WP 4.3 Interpretation of surface fractures related to the two large earthquakes.						
WP 4.4 Deformation associated with the two large earthquakes, GPS, InSAR, strain.						
WP 5 New methods for improving assessment earthquake effects. A group work.						
WP 5.1 Detailed mapping of distant faults by microearthquakes.						
WP 5.2 Detailed geological mapping of surface effects in a large area.						
WP 5.3 Study of the strong motion records, intensities, from the large earthquakes.						
WP 5.4 Reevaluations of historical earthquakes in light of the new observations.						
WP 5.5 Hydrological changes in a large area related to the earthquakes.						
WP 5.6 Analysis of paleo-stress fields and mechanism.						
WP 6 Integration of the modelling work. A new general model.						
WP 6.1 Model stress changes in Iceland based on historical activity.						
WP 6.2 Model stress in the solid matrix and pressures in fluids permeating the crust.						

Table 1. *Timetable for the first 6 months of the project. For each WP the red boxes show planned efforts and the yellow ones executed efforts.*

Workpackage number	IMOR		UU		UEDIN		NVI		UIB		SIUI		UPMC		DF.UNIBO		GFZ POTSDAM		CNRS-UMR 5562		UNIVTS-DST		CAU		WAPMERR		UI	
		%		%		%		%		%		%		%		%		%		%		%		%		%		%
WP1	11	25																										
WP2	2,5	130	0,5	0	1	0	1	0															1	0	1	0		
WP2.1																							9,5	25				
WP2.2																									9	10		
WP2.3							21	20											4	25								
WP2.4			21	15									0,5	0														
WP2.5	1,5	0			15	25																						
WP3	2,5	5	0,5	0							1	0																
WP3.1	1	0	12,5	10																								
WP3.2											10	0																
WP4	2,5	20					0,5	0			1	0									0,5	0						
WP4.1	13	45	0,5	0																								
WP4.2	1	0																			15	35					2,5	0
WP4.3							1	0			13	30																
WP4.4	1	5					11	25			0,5	0							1	0								
WP5	2,5	5					0,5	0	1	0			1	0							0,5	0					0,5	0
WP5.1	11,5	20																										
WP5.2	0,5	10					11	55																				
WP5.3	1	0																									16	30
WP5.4	8,5	10																									1	0
WP5.5									17	20			0,5	0	1	0												
WP5.6													7,5	45	1	0												
WP6	2	5									1,5	0			1	20	1	0	4	25								
WP6.1															6	25	15,5	20	1	0								
WP6.2															29	20			1	0								
Total	62	25	35	10	16	25	46	30	18	20	27	15	9,5	35	38	20	16,5	20	11	20	16	25	10,5	25	10	10	20	25

Table 2. *Planned and used manpower: The yellow columns show planned manpower (both permanent and temporary) for each partner in individual WP´s in man-months. The green columns show the used manpower in each case as percentage of the planned one.*

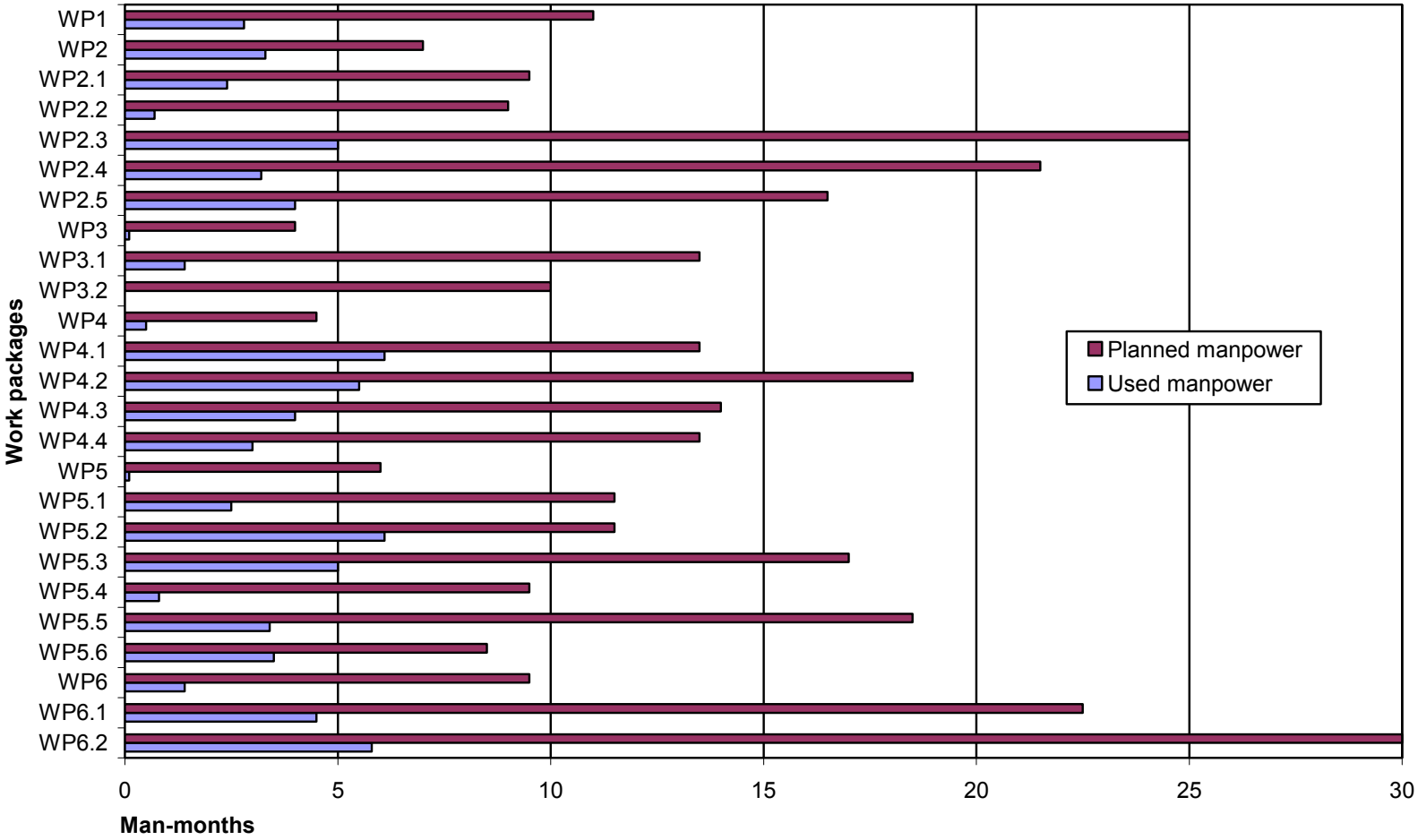

Table 3. *Planned and used manpower (both permanent and temporary) in each WP.*

Table 3