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Prepared by David Crossley and Jacques Hinderer, March 2002.

1. Minutes of the 3rd GGP Workshop, Jena

The 3rd GGP Workshop was held in Jena, Thuringen, Germany, from 11-13 March 2002. The GGP Business was conducted in two parts, at the beginning, Session 1, (Monday, 11 March) and the closing, Session 9, (Wednesday, 13 March). A list of the 40 participants is shown at the end of the minutes.

1.1 GGP Status Review

David Crossley (DC) and Jacques Hinderer (JH) welcomed the participants to the GGP meeting. DC started the GGP overview by showing the present existing map of the SG stations, pointing out the installation of the most recent ones (e.g. Ny-Alesund in Spitsbergen). The status of the database was then presented and shows that there are now more than 900 months of SG data available.

Two questions were raised concerning request for information that had been sent out to the station operators in August of 2001:

- the nature of the decimation filter used to decimate from raw data (1, 2, 5 or 10 sec) to 1 min samples. We had requested that every station send their filter coefficients to either DC or JH; this is considered important to show other stations the nature of the filters being used on the various data sets. A number of filters have been sent to the database but there are still many missing ones.
- the raw data (i.e. at 1s, 2s, .. sampling) from the June 2001 earthquake in Peru with magnitude 8.1. We had requested GGP files of the data from June 23 to June 30; however to this point only a few stations (5) have send their data to ICET.

1.2 ICET Review

Bernard Ducarme (BC) then gave a report on the GGP database hosted at ICET. There was a hardware problem last December which made any connection to the database impossible for a while, but everything eventually was fixed. He showed a tidal analysis of the data from all stations using GGP data, from which a noise estimate in the tidal band was obtained. He noted that there are problems with barometric pressure admittance values for some stations. The stability of the tidal factors from repeated tidal analysis is found to be excellent, of the order of 0.1 %.

1.3 Individual Station Review

There was then a short review of the station and prospects for each station:

- BA and KY – Bandung / Kyoto (Shuzi Takemoto): normal operation; but there is an urgent need for calibration in Bandung.

- BO – Boulder (DC): normal operation; BO will continue to operate at TMGO at least until the end of GGP-1 (July 2003), but the future of the instrument has not yet been decided. Some tilt control problems were detected and fixed.
- BR – Brasimone. DC noted that recording stopped in 2000 and the instrument was sent back to GWR for repair. Susanna Zerbini (SZ) indicated the possibility that the station may resume in future after a planned 5-th force experiment using the renovated SG.
- CA - Cantley did not have a representative at the Workshop. DC reported that to the best of his knowledge CA will continue until the end of GGP-1. A new person, Joseph Henton, from the Space Geodetic and Gravity Systems in Ottawa, will work with the SG and AG instruments in Cantley.
- CB - Canberra (Tadahiro Sato - TS): normal operation.
- ES - ESASHI (TS): normal operation. A helium problem was encountered in April 2001 leading to a careful set-up with higher quality of data later on.
- MB - Membach (BD): normal operation (+ rainfall and dam level data collected); this station will continue operating into the future.
- ME - Metsahovi (Heikki Virtanen): normal operation and continued operation.
- MO - Moxa (Corinna Kroner): normal operation; numerous environmental sensors have been installed around the station.
- NA - Ny-Alesund (TS): normal operation. There is careful maintenance by NMA (Norwegian Mapping Authority) and 3 different calibration experiments were done by AG in 1998, 2000 and 2001. An apparent gravity decrease related to uplift was confirmed in the data, as observed also by VLBI. Some problems related to the temperature stability of the station enclosure were mentioned.
- ST - Strasbourg (JH): normal operation. There was an installation of a permanent GPS receiver in the Fall of 1999 and a change in absolute pressure transducer with consequent problem in merging the data sets (adjusted drift or offset).
- SU - Sutherland (Jurgen Neumeyer): normal operation; an extended report was given separately.
- SY - Syowa (TS): normal operation ; there has been no tilt control since last summer. A new SG meter is expected to be installed next year.
- VI - Vienna (Bruno Meurers): normal operation. A change in the time lag due to new filter was noted. After the end of GGP1, in July 2003, this meter will be moved as quickly as possible to the Conrad Observatory, 60 km from Vienna.

- WE - Wettzell (BR): normal operation; there are still some missing data which will be sent soon to the ICET database.
- WU - Wuhan (H.-T. Hsu): normal operation. The instrument was calibrated twice and there was an installation of a permanent GPS receiver.

Comment (DC).

It appears that the majority of existing stations have plans to continue operations beyond the end of GGP-1. Vienna will move but restart operations at a nearby site. The two N. American stations (BO, CA) are at present the least clear about future prospects.

1.5 GGP Information System and Data Center

Bernd Ritschel and H. Palm described the status of the ISDC / GFZ database and the amount of data now available. There are 20 registrations as new guest users of the data. Ritschel mentioned the different upgrades done on the system.

GFZ is willing to offer the maintenance of the database after GGP-1 period, irrespective of where it is located. This is good news, particularly as the database will continue to accumulate SG data independently of whether there is a second GGP-2 period after July 2003. Ritschel reviewed the concept of a METADATA file in connection with data such as CHAMP / GRACE / GOCE and suggested the GGP database would benefit from a more extensive implementation of the metadata concept.

1.6 Plans for New Stations

From our existing present knowledge, there are some projects in installing new SG stations in the near future:

- **Walferdange** (Luxembourg): An SG has been installed in January 02 in the Underground Laboratory in Walferdange. The instrument designation is CT040 and the GGP station code will be WA. Preliminary coordinates are lat 49.665, long. 6.153, height 295 m. The instrument will contribute data to GGP. An absolute gravimeter has also been purchased by the ECGS for use in a number of projects.
- **Matera** (South of Italy): SZ indicated that the Italian Space Agency will place an order this year to install a meter in Matera in colocation with other geodetic instruments
- **Medicina** (near Bologna, Italy): both SZ and Bernd Richter (BR) agree that the Medicina station will continue for several years and that these data can be incorporated in the GGP database; this is important in the context of supplementing the Brasimone data which show large gaps and noisy features
- **Bad Homburg** (Germany): BR indicates that a new SG is running at this fundamental gravity station where former SGs have already shown the quality of the site.

- **Concepcion** (Chile): BR said that in the framework of the TIGO project, an SG will be installed for several years in the Southern coast of Chile. It will be a fully remote-controlled meter with its own helium liquefier and calibration will be performed every year.

Other projects are being considered and are awaiting decisions and/or funding:

- **Schiltach** (Germany): Walter Zurn said that an SG is planned at the BFO (Black Forest Observatory) to add to the numerous instruments (seismometers, gravimeter, tiltmeters, strainmeters) already in operation inside the mine.
- **Westerbock** (Holland): Ruben Ijpelaar spoke of some plans to install an SG in the Netherlands in order to study hydrological contributions to gravity.
- **South Pole** (Antarctica). DC reviewed as request by Rhett Butler (Manager, Global Seismic Network) to consider the installation of an SG at the SP to replace the existing IDA spring gravimeter. Several possible scientific advantages were discussed as well as some practical and logistic problems. The funding for such a gravimeter, ideally one of the self contained (no He refills) remote-controlled type, will need to be carefully justified.
- **Apache Point Observatory**. Tom Murphy (University of Washington, Seattle) approached GGP on the possibility of using gravimetry in connection with a proposed improved Lunar Laser Ranging (LLR) laboratory capable of determining the lunar distance to 1 mm accuracy. The installation is at Apache Point in New Mexico. The use of an SG is preferred over an AG for the continuous monitoring of vertical motion during the LLR experiments. Because no existing SG instrument is currently available for this, again the question of funding a new instrument arises.

This closed the Introductory Session of the GGP meeting

1.7 Session Summary

The following is a brief summary of the papers presented during the body of the Workshop; note that the authorship list is subject to changes as these papers go into the BIM proceedings.

Session 2 - Extended Station Reports

H. Virtanen: Summary of observation in Metsähovi 1994 - 2001 with SG T020

J. Neumeyer and Dierks, O.: Results from the SG registration in Sutherland (South Africa)

C. Kroner, Jahr, Thomas, and Jentzsch, G.: Comparison of the results obtained with a dual sensor superconducting gravimeter

Session 3 - SG Calibration

M. Amalvict, **Hinderer, J.**, Gegout, P., Rosat S. and Crossley, D.: On the use of AG data to calibrate SG instruments in the GGP network.

B. Richter, Harnisch, G., Nowak, I.: Experimental and computational contributions to estimate the accuracy and reliability of the Frankfurt Calibration System (FCS) .

M. Harnisch, Harnisch, G., and Falk, R.: Improved scale factors of the BKG superconducting gravimeters, derived from comparisons with absolute gravity measurements.

H.-P. Sun and Hsu, H.-T.: On the calibration for GWR superconducting gravimeter in China.

B. Meurers: Aspects of gravimeter calibration obtained by time domain comparison of gravity records.

Session 4 - Data Processing

A. P. Venedikov, Arnosó, J., and Vieira, R.: The new program VAV/2001 for tidal data processing.

J. Hinderer, Rosat S., and Crossley, D.: Influence of different processing methods on the retrieval of gravity signals from GGP data.

O. Dierks and Neumeyer, J.: Comparing investigations on programs for earth-tide analysis.

Session 5 - Free Oscillations

S. Rosat, Hinderer, J., and Crossley, D.: A comparison of the noise levels of various SG stations.

R. Widmer: What can superconducting gravimeters contribute to normal mode seismology?

X.E. Lei, **Hsu, H.-T.**, and Sun, H.-P.: The check of free oscillation modes by the registration of superconducting gravimeter at Wuhan.

W. Zürn, Bayer, B., and Widmer-Schmidrig, R.: The 3.7 mHz - gravity signal on June 10, 1991.

H.-P. Sun, Ducarme, B., and Xu, J.-Q.: Determination of the Free Core Nutation parameters by stacking tidal gravity measurements from GGP network.

H.-P. Sun, Ducarme, B., and Xu, J.-Q.: Experimental earth tidal models of the core resonance obtained by stacking tidal gravity measurements from 20 GGP stations.

D. Crossley and Hinderer, J.: GGP ground truth for satellite gravity missions.

T.F. Baker, Bos, M.S. and Williams, S.D.P.: Confronting superconducting and absolute gravity measurements with models.

Session 7 - Special Session

T.v. Dam and **Plag, H.-P.**: The IERS Special Bureau for Loading: Tasks and Products Discussion.

Session 8 - Tides

P. Varga: Tidal friction, quality factor and geodynamical properties in the remote geological past.

T. Sato, Y. Tamura, K. Matsumoto, H. McQueen, and Y. Imanishi: A comparison between the observed tides and theories.

B. Ducarme and Sun, H.-P.: New investigation of tidal gravity results from the GGP network.

B. Richter, Harnisch, M., Harnisch, G., Falk, R.: Long-period tides and absolute gravity measurements.

P. Varga, Mentés, Gy. and Eperne Papai, I.: Theoretical description of the extensional and rotational strain components.

1.8 Closing Session

DC proposed a number of resolutions to be adopted by the GGP members:

- (a) **Peru earthquake data.** Data from GGP instruments needs to be sent as quickly as possible to ICET following large earthquakes in order to be useful to the seismological community. BD indicated that data can either be uploaded as normal GGP data or sent by FTP. In particular we ask that stations that have not yet sent their Peru data, do so as soon as possible.
- (b) **Decimation filters** (from raw samples to 1 min samples); stations who have not yet sent these are asked to send them (i.e. the coefficients of the filter in time) directly to DC or JH. They will be added to the database where they will be put as a document file
- (c) **FCN stacking.** As a result of several presentations during the Workshop, JH offered to provide the FORTRAN source code for the Bayesian estimation for computing the FCN resonance in tidal gravity data. Given the non-Gaussian noise of the inversion of the tidal factors involved in the estimate, this is the preferred method of obtaining realistic Q values (an alternative method was outlined by T. Sato at the Workshop). The Bayesian code will be made available on the GGP Home Page. The reference paper is Florsch, N., & Hinderer, J., 2000. Bayesian estimation of the Free Core Nutation parameters from the analysis of precise tidal gravity data, *Phys. Earth Planet. Int.*, **117**, 21-35.
- (d) **Letters of Support.** GGP is very willing to send supporting letters to participating stations for the continuation of their SG operations and such request should be sent to DC or JH. For example, a letter will be sent to support the extension of the Ocean Hemisphere Project of our Japanese colleagues.
- (e) **Corrected Data.** DC presented a case for the extension of the file codes for corrected data. Due to the lack of time, this could not be discussed in detail at the meeting. Further details will be provided on the GGP Home page. For the moment, station operators are encouraged to send to the database their own corrected data with the agreed-upon code in the file name. JH insisted on the necessity of providing LOG files in order to identify clear problems and consequent offsets.
- (f) **Workshop Proceedings.** Proceedings of the two workshops (the GGP Workshop reported here and the Environmental Workshop that followed) will be published in the Bulletin d'Informations des Marees Terrestres (BIM). The papers can appear either as short contributions (a suggested length of 4 pages, if published elsewhere) or full papers without a length specification. The papers will not be formally reviewed, but will be checked by the editor.

The deadline for submission is **30 April 2002**. For the style of the paper, please look up recent BIMs. The format should be either in Microsoft Word, Postscript or LaTeX (or TeX). Tables and Figures should be placed in the text if desired; if attached separately they will be placed at the end of the paper.

Please send your contribution via e-mail, on a floppy disk or on a CD-ROM directly to

Corinna Kroner, Institute of Geosciences, Friedrich-Schiller-University,
Jena, Burgweg 11, 07749 Germany (kroner@geo.uni-jena.de).

- (g) **Special Publication.** Hans Peter Plag offered to publish GGP papers in a special issue of Physics and Chemistry of the Earth. DC proposed that this might be work as a selection of papers summarising the major achievements of the GGP-1 period; perhaps this could contain papers up to, and including, those to be presented at the IUGG meeting in 2003.
- (h) **Related Meetings.** Gerhard Jentzsch and SZ are offering to request a special GGP session at the 2003 joint EGS/AGU meeting in Nice; this session should belong jointly to both Geodesy and to Solid Earth sections.
- (i) **GGP Documentation.** Concerning the GGP Home Page, DC suggested that there should be listed for every station a file giving all required information on the instrument history at that site. Particularly important are values for the gravity and pressure calibration constants, phase lag (or time delay) experiments, changes in instrumentation, etc. BD proposed in addition that ICET provides for every station a file indicating the tidal gravimetric amplitude and phase factors (with the proper time delay INCLUDED). Such a file could be directly used in the program TSOFT to compute the local theoretical tide for each station.

1.9 Next GGP Workshop

A discussion followed on the location of the next GGP Workshop. Prof. Takemoto outlined the schedule of the next IUGG meeting. All the GGP members consequently agreed that the final workshop of the GGP1 period (1997-2003), will be held during the IUGG meeting in **Sapporo, Japan, in August 2003**, most probably on Sunday, 6 July, in the middle of the conference. Prof. Takemoto agreed to seek accommodation for up to 50 members at a convenient location on this day.

1.10 Thanks to the Organising Committee

GGP wishes to thank Prof. Gerhardt Jentzsch, Dr. Corinna Kroner and supporting staff of the Institut für Geowissenschaften in Jena for organising the GGP Workshop and supporting the travel of some scientists.

1.11 List of Participants:

Martine Amalvict (EOST / IPG Strasbourg) mamalvict@eost.u-strasbg.fr

Trevor Baker (Proudman Oceanographic Laboratory, Bidston) tfb@pol.ac.uk

Janus Bogusz (Warsaw University of Technology) jb@gik.pw.edu.pl

David Crossley (EOST / IPG Strasbourg / St. Louis University), crossley@eas.slu.edu

Olaf Dierks (GFZ Potsdam) dierks@gfz-potsdam.de

Bernard Ducarme (Royal Observatory, Brussels), ducarme@oma.be

J. Exss (University of Karlsruhe) jan.exss@gpi.uni-karlsruhe.de

Reinhard Falk (BKG, Frankfurt) falk@iers.org

Kasper Fischer (*Institut für Geowissenschaften, Jena*) kfischer@geo.uni-jena.de
Karl Gerstenecker (*TU Darmstadt*) gerstenecker@geod.tu-darmstadt.de
Günter Harnisch (*formerly BKG, Frankfurt*) gha@potsdam.ifag.de
Martina Harnisch (*formerly BKG, Frankfurt*) mha@potsdam.ifag.de
Jacques Hinderer (*EOST / IPG Strasbourg*), jacques.hinderer@eost.u-strasbg.fr
H.-T. Hsu (*Chinese Academy of Sciences, Wuhan*) hshu@asch.whigg.ac.cn
Ruben Ijpelaar (*Wageningen University, Netherlands*) ruben.ijpelaar@users.whh.wau.nl
Thomas Jahr (*Institut für Geowissenschaften, Jena*) jahr@geo.uni-jena.de
Gerhard Jentzsch (*Institut für Geowissenschaften, Jena*) jentzsch@geo.uni-jena.de
Klaus Klinge (*SZGRF Erlangen*) klinge@szgrf.bgr.de
Thomas Klügel (*FESG, TU München*) kluegel@wetzell-ifag.de
Alexander Kopaev (*Sternberg Astronomical Institut of Moscow*) kopaev@sai.msu.ru
Corinna Kroner (*Institut für Geowissenschaften, Jena*) kfischer@geo.uni-jena.de
Gyula Mentés (*Institut of Hungarian AS*) mentes@gghi.hu
Bruno Meurers (*University of Vienna*) bruno.meurers@univie.ac.at
Jürgen Neumeyer (*GFZ Potsdam*) neum@gfz-potsdam.de
H. Palm (*GFZ Potsdam*) palm@gfz-potsdam.de
Hans-Peter Plag (*Norwegian Mapping Authority*) plag@statkart.no
Bernd Richter (*BKG Frankfurt*), richter@iers.org
Bernd Ritschel (*GFZ Potsdam*) rit@gfz-potsdam.de
Séverine Rosat (*EOST / IPG, Strasbourg*) srosat@eost.u-strasbg.fr
Tadahiro Sato (*NAO, Misuzawa*) tsato@miz.nao.ac.jp,
He-Ping Sun (*Chinese Academy of Sciences, Wuhan*) heping@asch.whigg.ac.cn
Shuzo Takemoto (*Kyoto University*) takemoto@kugi.kyoto-u.ac.jp
Peter Varga (*Institut of Hungarian AS*) varga@seismology.hu
Angel Venedikov (*Geophysical Institut, Sofia*) vened@geophys.bas.bg
Heikki Virtanen (*Finnish Geodetic Institut*) hv@fgi.fi
Malte Westerhaus (*University of Karlsruhe*) westerhaus@gik.uni-karlsruhe.de
Rudi Widmer (*BFO, Schiltach*) widmer@geophys.uni-stuttgart.de
Susanna Zerbini (*University of Bologna*) zerbini@df.unibo.it
Walter Zürn (*BFO, Schiltach*) wzuern@gpi.uni-karlsruhe.de

Apologies for any errors, misprints and omissions.