

# National Report of Austria

N. HÖGGERL<sup>1</sup>, G. STANGL<sup>2</sup>

## 1. Introduction

The department „Control Survey“ of the Austrian Federal Office of Metrology and Surveying (BEV) is responsible for the realisation of reference frames for horizontal and vertical control as well as for the establishment and maintenance of the gravity base network and the determination of the local gravity field. There is a close co-operation with the Observatory Lustbühel-Graz (OLG) which belongs to the Austrian Academy of Sciences. Close co-operation was established especially concerning projects related to satellite geodesy.

Further co-operations have been initiated with a number of departments of the universities Graz and Vienna in the field of gravity (geoid determination, Bouguer-map of Austria,...).

The following projects are still in progress:

- Fundamental GPS-Networks and Permanent Stations
- Transition to ETRS/UTM
- Vertical Control/new height system
- Gravity and Gravity Field Determination

## 2. Fundamental GPS-Networks and Permanent Stations

### • CERGOP-2

The CERGOP campaigns 1994-1999 have been combined to estimate differential velocities in Central Europe. The campaigns CEGRN'94 and CEGRN'95 have been re-processed to obtain comparable normal equations and SINEX files. Due to problems with the Bernese Software the results are not yet ready. The first investigation showed that the individual velocity differences are near the level of significance.

### • Permanent Stations

Two new permanent stations (HKBL-Hauser Kaibling, VLKM-Völkermarkt) were added to the Austrian network (at present 11 stations are in operation), four additional stations will be available by end of 2001. All stations are recording data with 1-sec sample rate and place at disposal hourly 30-sec RINEX data stored at the Data centre Graz.

### • EUREF Data and Analysis Centre OLG

OLG data centre stores RINEX data of about 60 permanent stations, most of them included into the EUREF network. All data are checked by standard

---

<sup>1</sup> Norbert Höggerl, Federal Office of Metrology and Surveying (BEV), Schiffamtsgasse 1-3, A-1025 Vienna, Austria, email: [norbert.hoeggerl@bev.gv.at](mailto:norbert.hoeggerl@bev.gv.at).

<sup>2</sup> Günter Stangl; Federal Office of Metrology and Surveying (BEV); Aussenstelle Graz-Lustbühel;  
c/o Institut für Weltraumforschung Abt. Satellitengeodäsie (IWFSG), Elisabethstraße 20, A-8010 Graz; Austria, email: [guenter.stangl@oeaw.ac.at](mailto:guenter.stangl@oeaw.ac.at)

programs as compress/uncompress, Hatanaka compress/uncompress and teqc (UNAVCO). The data centre acts as a EUREF LDC, the CERGOP DC and the national DC. GPS 24h-RINEX, 1h-RINEX and GLONASS data are stored. The ftp-server has been moved to a more secure location because of several network outages. A further change for security reasons is planned for June 2001.

The OLG analysis centre computes several networks each week. The networks are:

- a) ARE (Austrian Reference Extended) and CERGOP, extending from Norway to Bulgaria and including all CERGOP permanent stations, two ambiguity fixing strategies, L5/L3 and QIF are used; about 50 stations
- b) EUREF (EUREF subnetwork OLG) extending from Norway to Israel; about 30 stations
- c) MON (Monitoring network of the Balkan, Anatolia and Near East region, EUREF region VI) extending from Romania to the Near East; about 10 stations
- d) DGPS-A (Differential GPS Austria), all free permanent stations within Austria; about 15 stations.

All networks are processed using the EUREF standards with slight extensions (e.g. lowest elevation angle 10°).

- **COST-716**

Contributions to the EU COST action 716 were given in the frame of WG-1 and WG-2.

The realisation of an Alpine GPS network consisting of 60 – 80 stations which will deliver total zenith delays in near real-time is in preparation.

### **3) Transition to ETRS/UTM - state of the work**

The Austrian National Survey is running a project aiming at the finally introduction of the international reference system ITRS/ETRS as the national reference frame for all geodetic and mapping applications in Austria. The UTM projection will serve as a base for the transition to 2-dimensional co-ordinates. Until now the following steps towards the above mentioned objectives have been made:

- **Transformation procedures**

Two different sets of transformation parameters are available: Firstly, the global transformation for the entire country of Austria ( $\pm 2$  m), and, secondly, regional "transformation vectors" with a transformation-precision of  $\pm 0,1$  m (see fig. 1). These "transformation vectors" have been derived from 1988 points, regularly distributed all over the country

- **GPS-network AGREF and additional GPS-measurements**

In 1997 the Austrian Geodynamic Reference Frame (AGREF) was finished. This GPS network consists of about 100 reference points and serves as a base for additional GPS measurements. These "additional GPS measurements" (AGM)

are necessary to stabilise the existing triangulation network. Until now 60% of these AGM have been done - that means that 12.000 reference points out of about 20.000 have been observed so far.

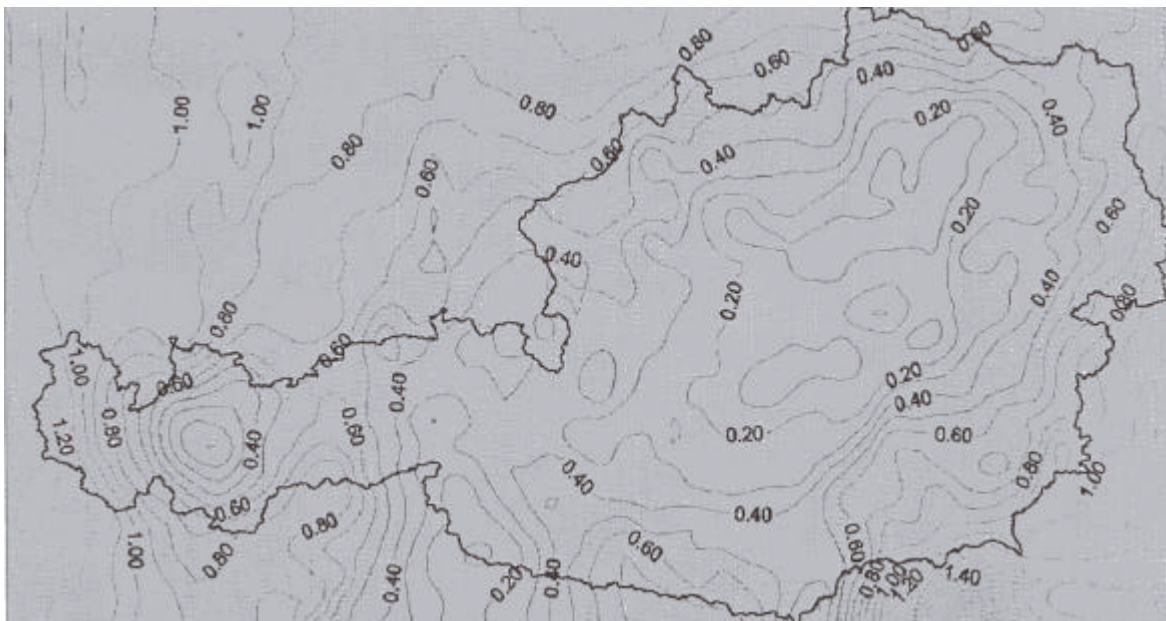


Figure 1: Inhomogeneity of the triangulation network 1<sup>st</sup> to 3<sup>rd</sup> orders (unit: meter)

The existing reference points of 1<sup>st</sup> to 5<sup>th</sup> orders, determined by trigonometric measurements, will be included in the frame of AGREF and AGM. To do this computational work it is necessary to digitise the old measurement-data (43% of this work has already been done).

To get a well-defined, homogenous 3-d point field, it is necessary to improve the height information, too. On the one hand GPS and trigonometric information will be computed by use of the ellipsoidal height component. On the other hand, the use of the geoid information transforms the ellipsoidal heights into physically defined heights (orthometric heights).

#### 4. Vertical Control

- **Orthometric Height System**

The computation of the Orthometric Height System of Austria is carried on. For 80% of the Austrian precise levelling points (30.000 bench marks in total) the geopotential C-values have already been computed with reference to the UELN95/98.

These C-values serve as a basis for the computation of orthometric heights, but on demand the normal height values are available, too. During the computation procedure not only C-values for the precise levelling points were computed, but also the trigonometric reference points along the levelling line were included as well. This is being done because in Austria, the Orthometric Height System is introduced for both levelling and trigonometric reference points.

The necessity for the introduction of a well-defined height system can be seen in figure 2. The differences  $\Delta h$  between the old (normal orthometric height system) and the new height system are presented for one levelling line in the westernmost

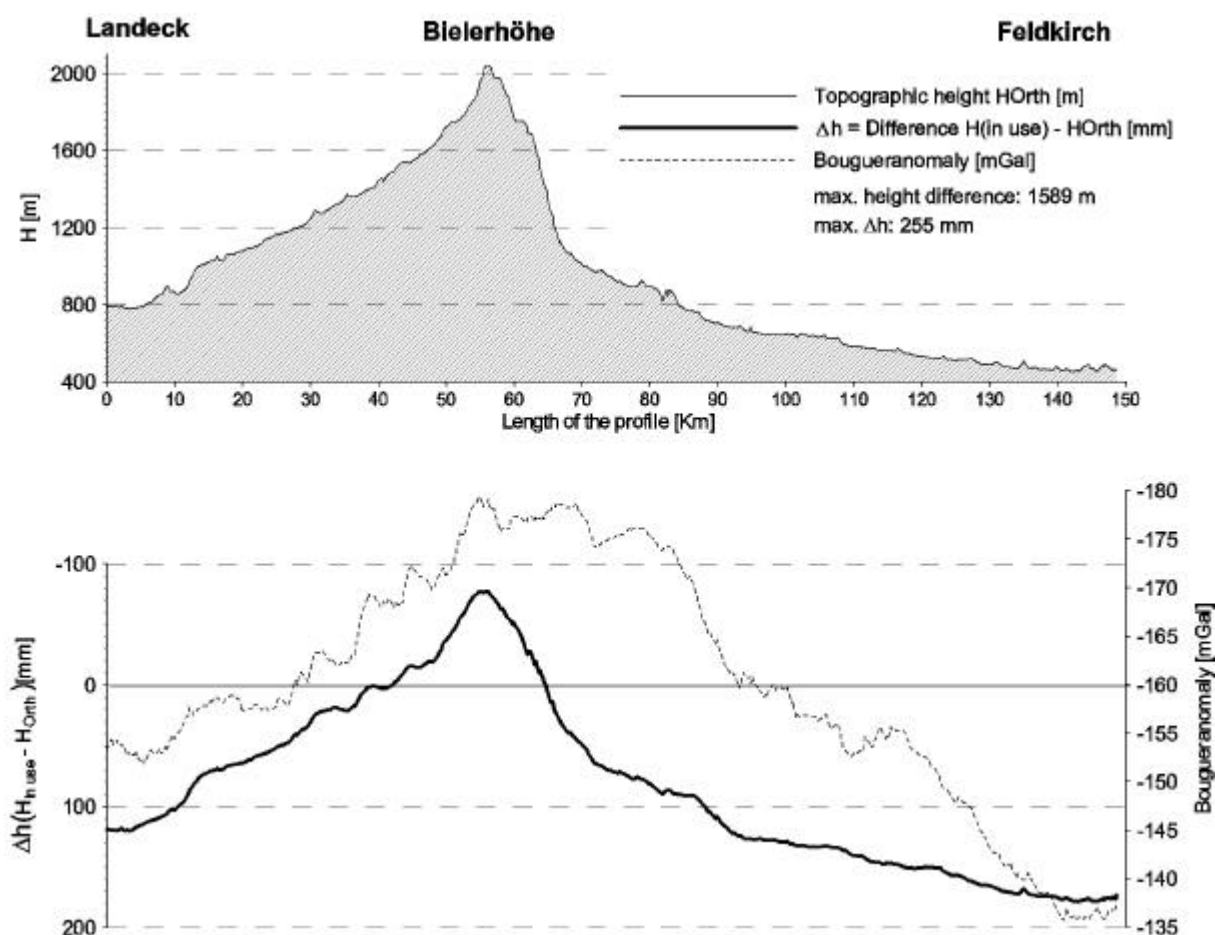


Figure 2: Differences of heights between the new and old height system in Austria

Austrian federal province - Vorarlberg. Within a distance of 60 km a  $\Delta h$  up to 20 cm appears (for topographical height differences of 1600 m).

This new height system is already used for the first time for the railway tunnel through the Brenner (Brenner Basis Tunnel) which is about of 50 km long and for which a feasibility study is being made.

- **Densification of EUVN**

With respect to the EUREF resolution No. 3 of Tromsö (year 2000) in addition to the originally introduced 5 Austrian EUVN points (GRAZ, PFÄNDER, WÖRGL, THÖRL, HUTBIEGL), some more points were included into the EUVN and serve as fiducial points for the determination of the geoid. About 60 points have been determined by trigonometric, GPS and levelling measurements. The distribution of the EUVN points is given in figure 3. In some regions there is a very high density of these points. That is due to the fact that in these parts of Austria (Carinthia), a very high density was necessary for other geodynamic research projects.

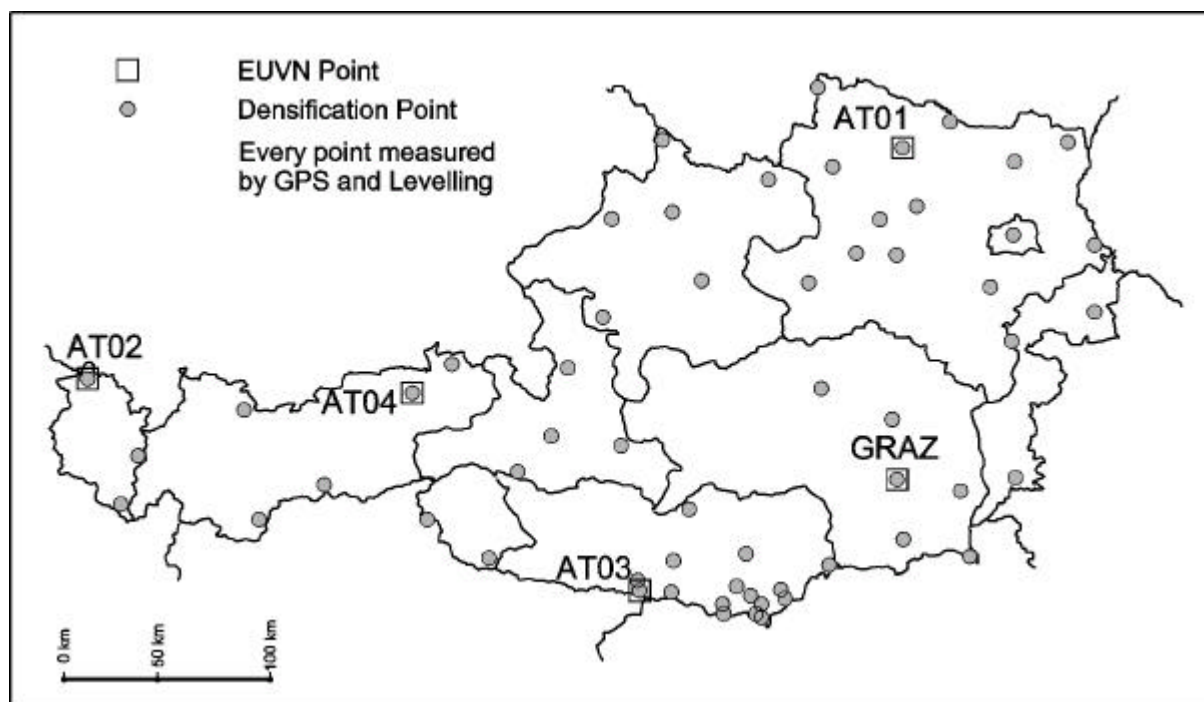


Figure 3: Distribution of EUVN- and densification-points in Austria

## 5) Gravity and Gravity Field Determination

- **UNIGRACE** (Unification of Gravity Systems in Central and Eastern Europe)

During the second measurement campaign, the Austrian absolute gravimeter JILAg-6 observed the stations Modra (Sk), Bogensperk (Sl), Trieste (I), Graz (A). In addition to the above mentioned measurements the reference stations Wettzell (D) and Jozefoslaw (Pl) were observed, as well.

The Polish team carried out absolute gravity measurements at the Observatory Graz-Lustbühel on 3 days in April 2001.

The results of the second measurement campaign were discussed at the UNIGRACE workshop in Vienna in May 2001. The closing conference of this EU-project is planned to be held in Trieste at the end of May 2001.

- **Recent gravity changes**

In Obergurgl (1930m)/Tyrol, twice a year, absolute gravity measurements have been performed since 1987. These measurements have shown increasing gravity values: +20 $\mu$ gal over the past 13 years.