Institut für Geophysik der Montan-Universität Leoben

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ACTIVITIES OF THE INSTITUTE OF GEOPHYSICS OF THE MINING UNIVERSITY LEOBEN IN THE INTERNATIONAL GEODYNAMIC PROJECT

by

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With 18 Figures

The investigations of the Leoben working group refer to the following research projects:

1. Geophysical geotraverses in the easternmost part of the Eastern Alps and the Alpine-Pannonic boundary region (gravimetry, magnetics, seismics).
2. Petrophysical measurements (density, magnetic susceptibilitiy, longitudinal velocity) in the same area.
3. Geothermal measurements in the area of Styria and Burgenland.
4. Paleomagnetic investigations on Miocene and Pliocene volcanites in the area of eastern Styria.

1. Introduction

Geological investigations in the easternmost part of the Alps yield new and very important results which change the structures of this region. The proven existence of extended penninic windows in the area have far reaching consequences for the clarification of nappe structures. These observations demonstrate the necessity of our project and the validity of the chosen geophysical program. With regard to the latest geological and geophysical evidence a broad geotraverse was planned reaching from the Wechsel area to the Hungarian border, which crosses all the important geological units, in order to obtain further information. Furthermore the data was connected to the Hungarian net of measurements where the results are proven by deep seismic sounding and deep wells.

In 1975 a strong impuls was given by the Alpine Longitudinal Profile sponsored also by the Geodynamic Project organisation. We obtained information down to the Moho discontinuity in the immidiate southern neighbourhood of our project area. Following this, the geotraverse 3 was planned to supplement the seismic data with results from other methods.

In the last year of the project we attempted in part to fill the area between the traverses with a net of magnetic and gravemetric measurements.

The density of measuring points in the area is such that the results contributed to the regional geophysical survey of Austria. This forms a basis for the continuation of geophysical research in selected areas and selected topics where interdisciplinary cooperation exists.

2. Magnetics

Measurements of the magnetic vertical component on three regional traverses have been carried out, in the easternmost part of the Central Alps and the adjoining Tertiary regions, to study the deep structure and nappe systems on the eastern border of the Alps. A map of the surveyed area is presented in figure 1. About 8000 readings in an area of approximately 1000 km². Normally the average stadion density was 4/km² but in areas of important anomalies station density was increased to 10/km². Additional micromagnetic studies (grid 5 x 5 or 10 x 10 m) were most helpful in determining main tectonic directions.

Susceptibility determinations, discussed in the later chapter „Petrophysics" show significant key rocks in the different Penninic and East Alpine geologic-tectonics units. For most of the Miocene and Pliocene volcanic rocks in the Styrian Tertiary basin high susceptibilities were observed, where the Tertiary sediments show very small values.

The results of N-S magnetic traverse 1 have been published in Austrian IGP-report 1975 (short note) and later by WALACH [9]. Isanomalic maps of the W-E traverse 2, connected to traverse 1 near Waldbach, show characteristic anomalies indicating a continuation of the Penninic Rechnitz Series under Lower East Alpine nappes (Wechsel- und Grobgneiss Series) about 40 km to the west. Figure 2 is a cross section of the western part of traverse 2, showing the above mentioned geological situation deduced from geophysical model calculations. As an example the model calculation of the NNE striking anomaly near Schäffern is shown in figure 3.

In the eastern part of magnetic traverse 2, W of Lutzmannsburg the main strike direction of anomalies is ENE, corresponding well to the general striking of the adjoining Penninic Series.

The nearly 100 km long magnetic traverse 3 covers the „Alpine Longitudinal Profile" (Alp 75), section 5, from E of Graz to the Hungarian border. Isanomalic maps and the model calculation shown in figure 4, reflect extension and depth of buried Miocene volcanics within Tertiary layers near Ilz and show two parallel, NNE striking, W dipping, prism-shaped disturbing bodies along the Hungarian border near Eberau, whose exact geological meaning up till now is unknown.

The comprehensive results, including all previous magnetic investigations in this area, has presented OBERLADSTÄTTER, WALACH and WEBER in EGS-meeting, Vienna 1979 [6].

3. Gravimetry

The gravimetric measurements were started in 1977 in the area between 47° 15'—47° 30' N, 15° 50'—16° 50' E and fieldwork was finished in August 1979. A location map is shown in figure 5. Till now 540 stations over an area of approximately 1600 km² have been measured.

In a montainous country the topographic corrections are a very important factor in gravity interpretation. Therefore, to enhance the accuracy of results a digital terrain model of the surveyed area on a grid of $\Delta\phi$ = 0,1975' and Δ = 0,3125' (approximately 350 x 380 m) on base of the Austrian topographic maps 1 : 25.000 and 1 : 50.000 was developed. In connection, with a detailed density model on an equal grid, high precision position- and elevation controls for the field stations and specific computer techniques, it will be possible, to reduce the errors in Bouguer anomalies to very small magnitudes. Computer programs for correcting and analyzing gravimetric data have been prepared. Initial results as a Bouguer map calculated with standard density 2,67 g/cm³ will be published in the last quarter of 1979.

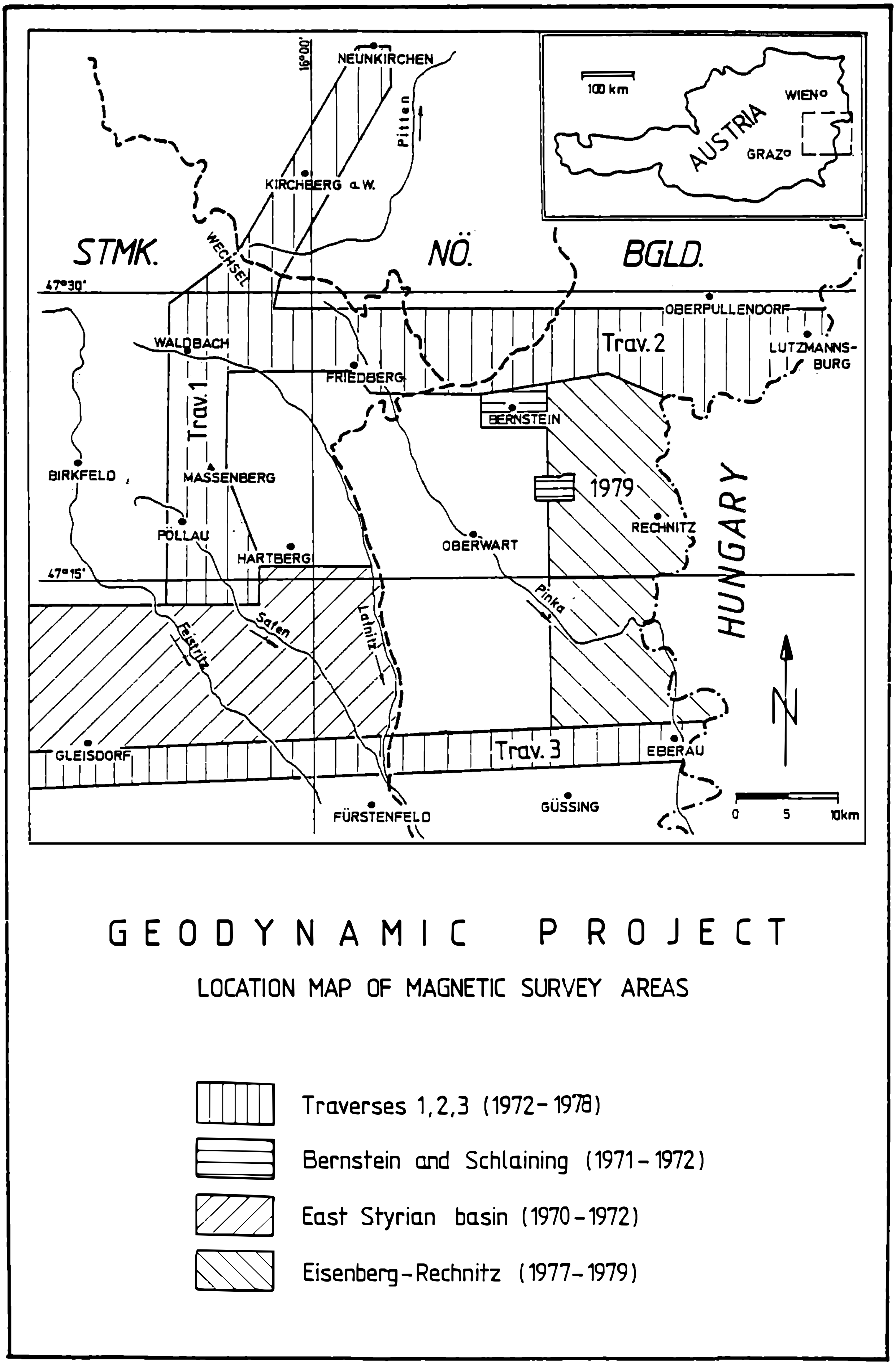


Fig. 1: Location map of magnetic survey areas

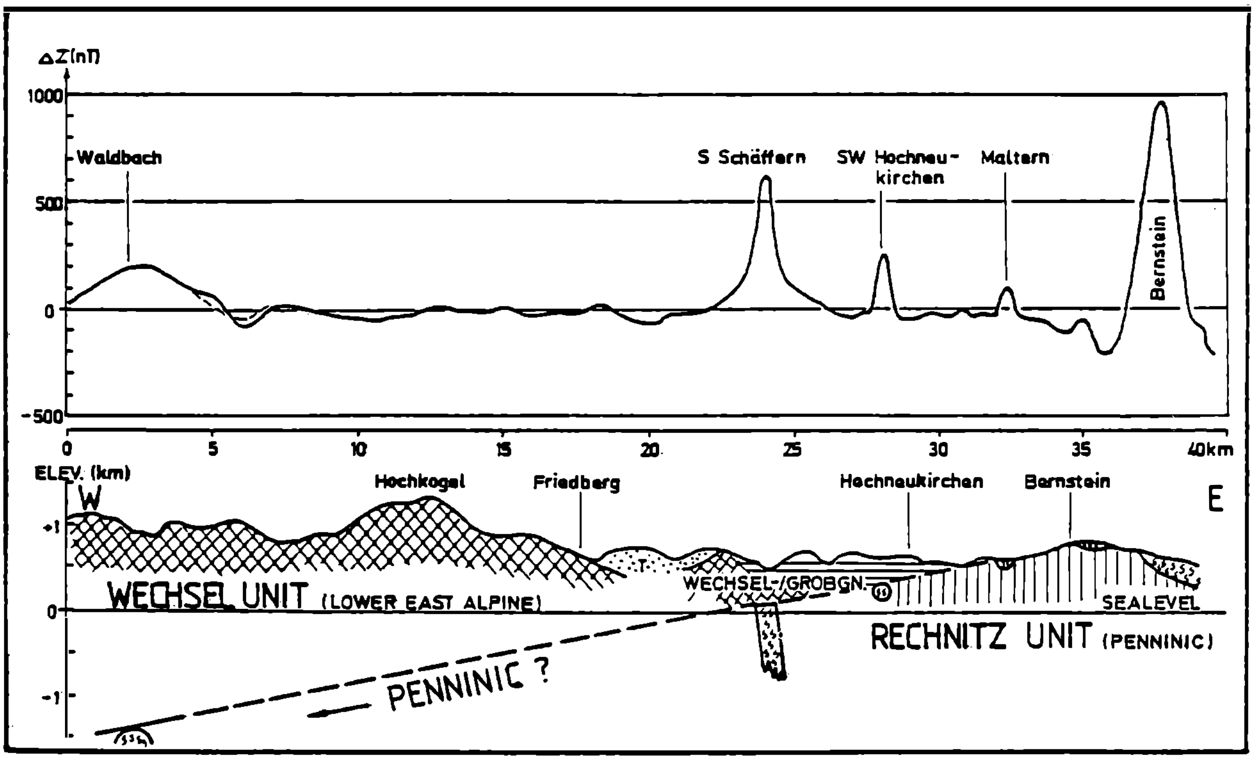


Fig. 2: Magnetic profil and interpretation of traverse 2

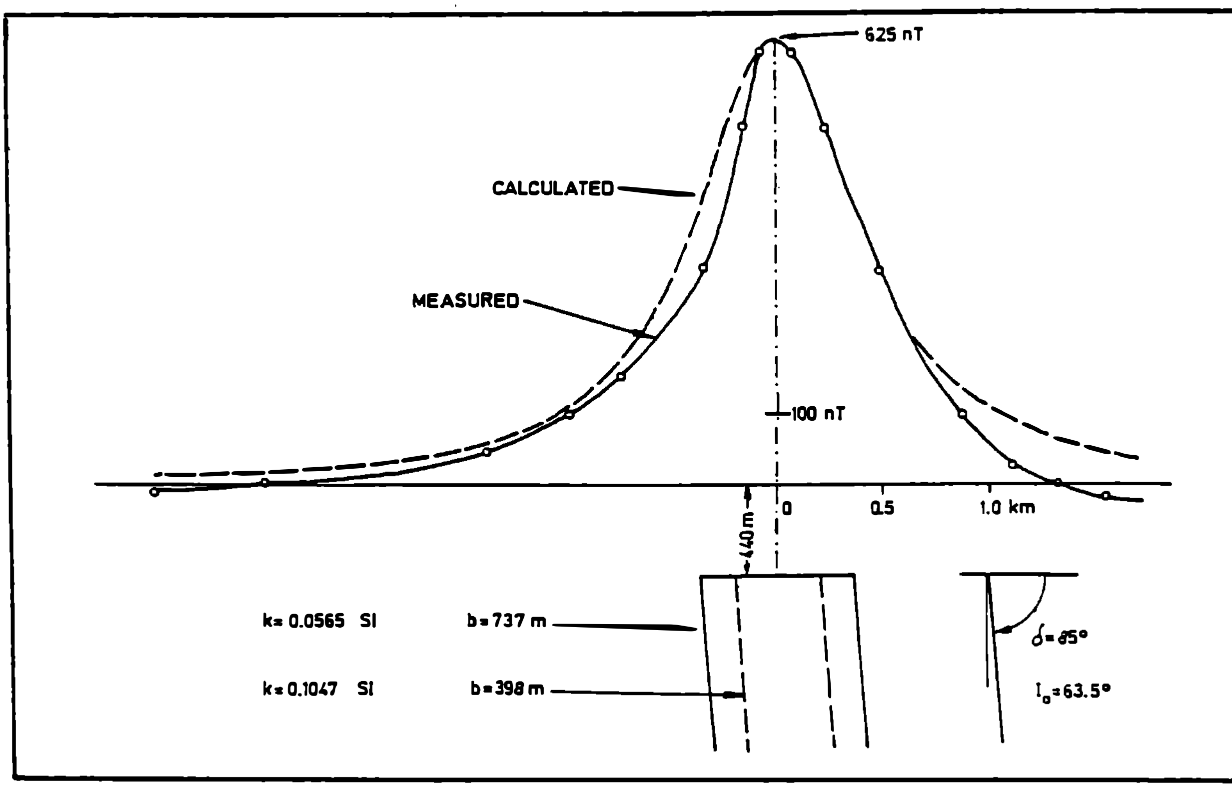


Fig. 3: Model calculation of the Schäffern anomaly (Magnetic traverse 2)

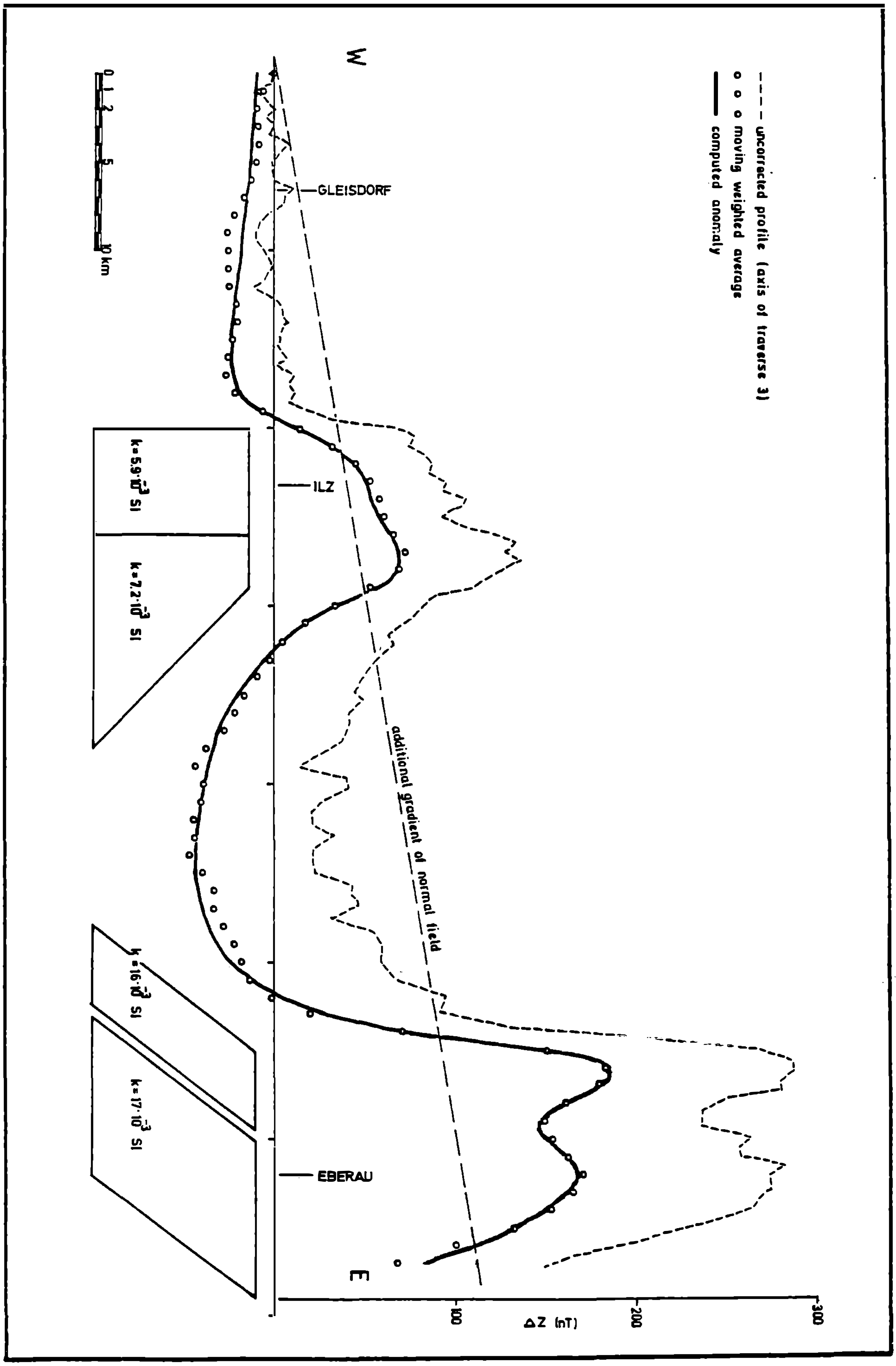
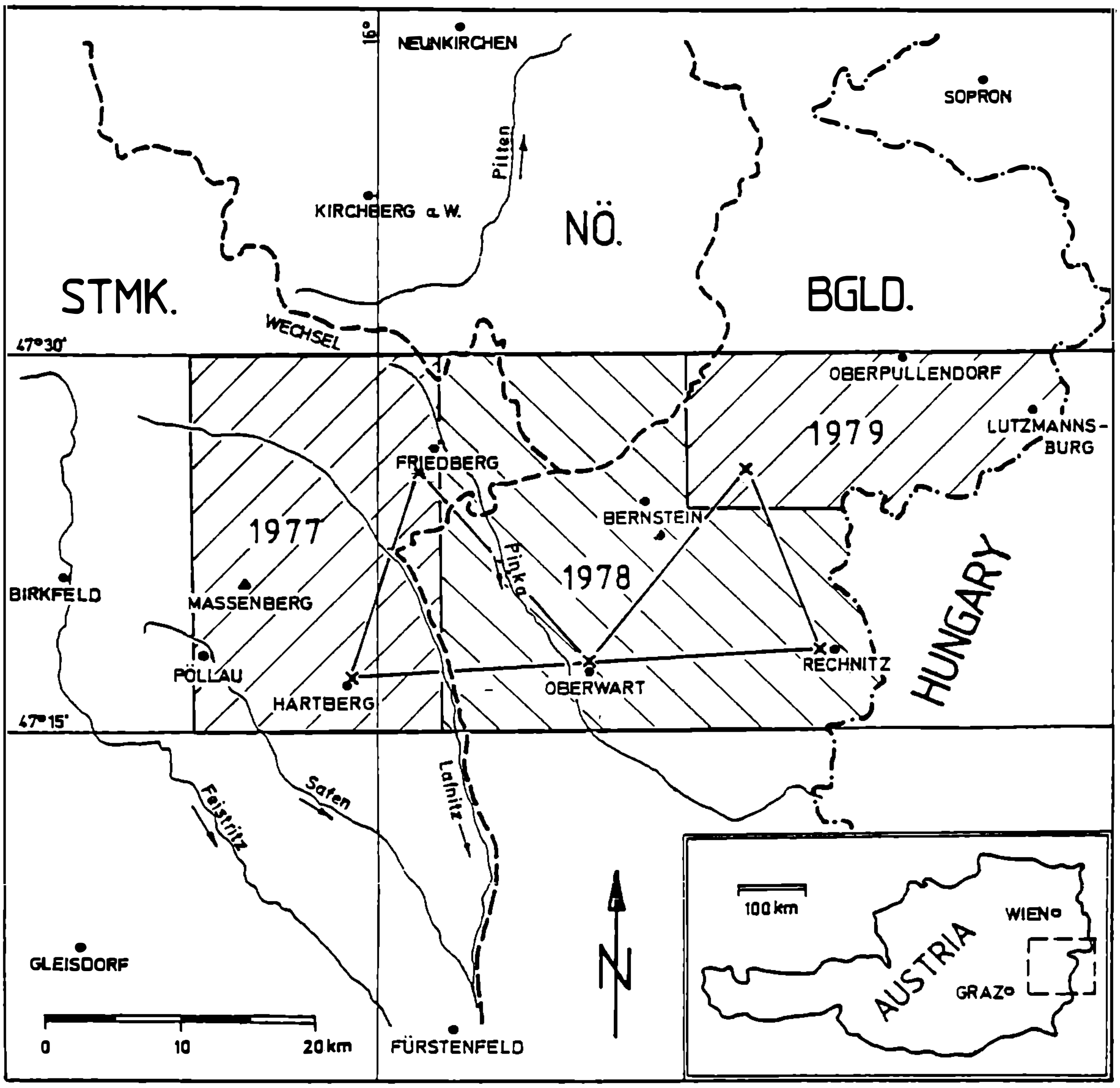


Fig. 4: Model calculation for magnetic traverse 3



GEODYNAMIC PROJECT

LOCATION MAP OF GRAVIMETRIC SURVEY AREA

× Base stations connected to the Austrian gravity network

Survey area approx. 1600 km^2, 540 stations

Fig. 5: Location map of gravimetric furvey area

4. Petrophysics

Contemporaneous to the geophysical investigations, a study of petrophysical parameters was performed. Measurements of magnetic susceptibility, density and longitudinal velocity on nearly 1500 rock specimes were made, additionally supported by a high number of "in situ" measurements of susceptibility and longitudinal velocity. Measurements of remanent magnetisation will be made in near future.
The present available data have been statistically analyzed and grouped, according to variations of the above mentioned parameters, to give reliable petrophysical models of the surveyed area. Tables 1 and 2 give a general review of the results.

Table 1: Densities (g/cm³) and susceptibilities (10^{-3} SI)

Series	Rocks	Density	Susceptibility
Rechnitz	Carbonateschists	2,72	0,2
(Penninic)	Carbonatephyllites	2,70	0,2
	Quartzphyllites	2,66	0,1
	Marbles	2,72	<0,1
	Sericitephyllites	2,67	1
	Ophicalcites	2,78	5
	Greenschists	2,96	0,7
	Serpentinites	2,61	36
	Serpentinites (with magnetite blasts)	2,98	160
	Conglomerate (Cak)	2,75	<0,1
Wechsel	Albitegneisses	2,70	0,6
(Lower E. A.)	Micaschists	2,68	0,6
	Amphibolites (diaphtoritic)	2,92	0,7
	Greenschists	2,87	50
Grobgneiss	Micaschists	2,70	0,2
(Lower E. A.)	Aplitegneisses	2,62	0,3
	Granitgneisses	2,68	0,3
	Metagabbros	2,95	0,6
(Permomesozoic)	Quartzites	2,66	<0,1
Sieggrabner	Paragneisses	2,63	0,3
(Middle E. A.)	Amphibolites	2,88	24
	Eclogites	3,36	2
	Serpentinites	2,53	32
Hannersdorf	Dolomites	2,76	<0,1
(Upper E. A.)	Rauhwacke	2,28	<0,1
	Greenschists (a, b)	2,86	0,6
			35
	Miocene volcanites (andesitic)	2,64	2 . . . 40
	Pliocene volcanites (basaltic)	2,80	12

Table 2: Longitudinal velocities in m/sec (Maltern and Friedberg area)

Series	Rocks	in situ-measurements (shotpoint-distance >200 m)	ultrasonic measurements
Rechnitz	Carbonateschists	3300 — 3800	5040
	Carbonatephyllites	3300 — 3800	6270
	Sericitephyllites	3000 — 3800	6000
	Greenschists	2600 — 3600	5290, 6270
	Dolomites	—	5290
	Gabbro-Amphibolites	—	7350
	Antigorit-Serpentines	4800 — 5000	6070
	Breunerit-Serpentines	—	4060
Wechsel	Albitegneisses	4100 — 5000	—
	Albitegneisses, cracked	—	2940
	Micaschists	4100 — 4500	5600
	Plagioglasamphibolites	—	5200
	Amphibolites, diaphtoritic	4800 — 5400	4890
	deeper horizons (?)	5500	—
Grobgneiss	Micaschists	3500 — 4500	—
	Aplitegneisses	4500 — 5000	4290
	Granitegneisses	4800 — 5000	—

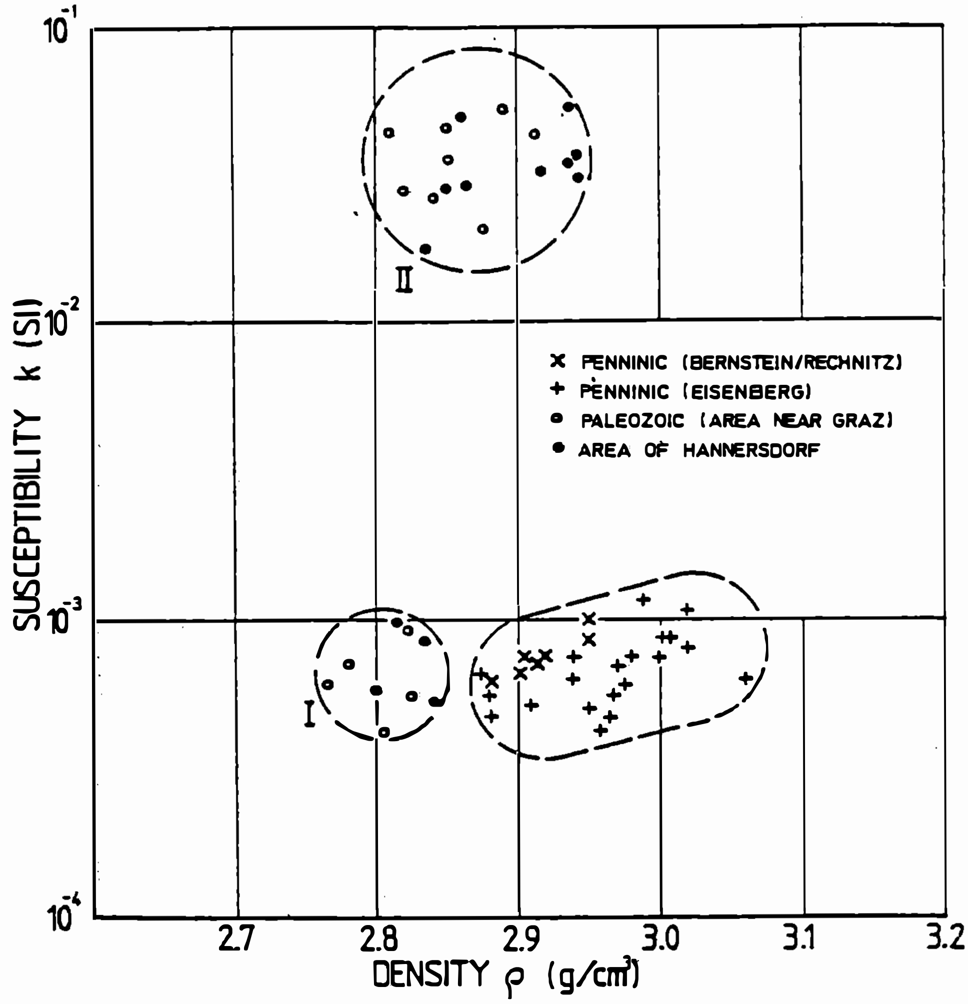


Fig. 6: Crossplot susceptibility versus density of several greenschists

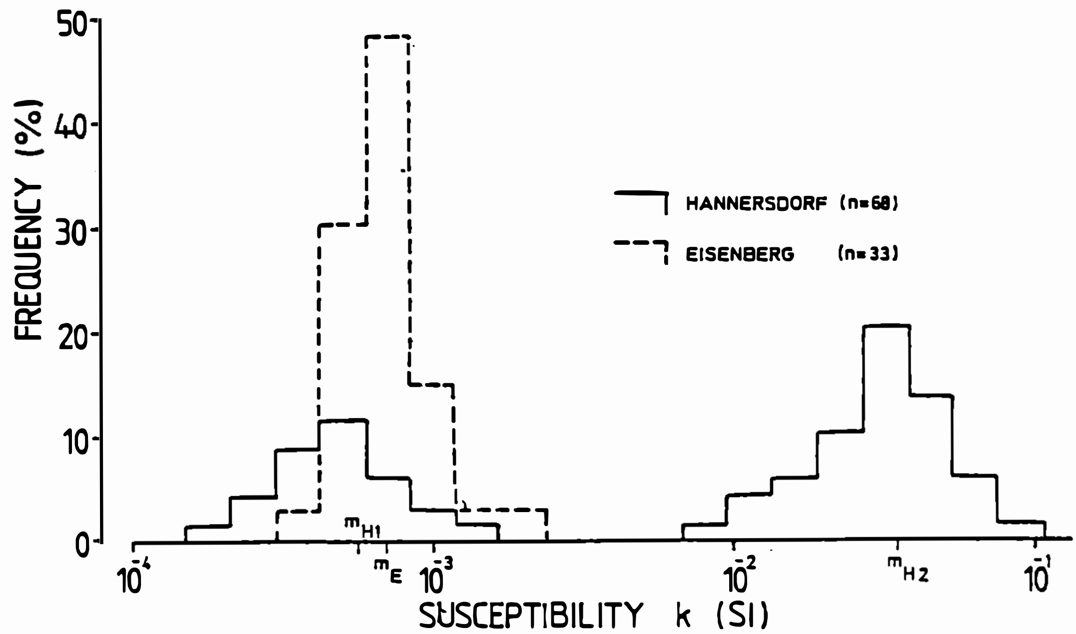


Fig. 7: Frequency distributions of susceptibilities from greenschists of Eisenberg and Hannersdorf

Susceptibility observations show significant variations in the rocks of different Penninic and East Alpine geologic-tectonic units. In the Penninic Rechnitz Series different ophiolites, mainly serpentinites show high susceptibilities up to 240.10^{-3} SI-units (mean value 35.10^{-3}). In the Wechsel Series greenschists are marked by high values up to 60.10^{-3} (mean 50.10^{-3}), but the gneisses and micaschists of the Grobgneiss Series have uniformly very low susceptibilities (mean $0,3—10^{-3}$ SI-units). Most of the Miocene and Pliocene volcanic rocks within the Styrian Tertiary basin have also high susceptibilities [2, 3, 8]

Density measurements on rock specimens of the Wechsel- and Grobgneiss Series show only small density variations and confirm the assumption, that the standard density of 2,67 g/cm^3 is a good estimate for the gravimetric corrections. In the Rechnitz Series marbles, carbonateschists, ophicalcites, greenschists and partly serpentinites (due to the content of magnetite) have higher densities up to 3,05 g/cm^3. The mean value for all Penninic rocks is in the range of 2,75 g/cm^3.

A two-dimensional frequency plot of susceptibility versus density (figure 6) often give important informations on the rocks in question. In the Eisenberg/Hannersdorf area (see figure 1) two types of greenschists occur. The greenschists of Eisenberg show identical petrophysical properties to the Penninic Rechnitz greenschists-mean density 2,96 g/cm^3 and a unimodal susceptibility distribution (mean $0,7.10^{-3}$). However, the greenschists of Hannersdorf have a mean density of 2,86 g/cm^3 and a significant bimodal susceptibility distribution with partial mean values of $0,6.10^{-3}$ and 35.10^{-3} SI-units (figure 7). This difference could be an indication, that the greenschists of Hannersdorf are a part of the adjoining Upper East Alpine nappe relics. A comparison of this data with data from the greenschists of the Upper East Alpine area near Graz ("Grazer Paläozoikum") in figure 6, confirms this assumption.

Refraction seismic surveys in some parts of traverse 2 (Maltern 1971, 1977; Pinggau-Friedberg 1976), completed by ultrasonic measurements in the laboratory, were performed to get informations about the longitudinal velocity and about the distribution of the different rock members to a depth of about 300 m. After PAHR (1972) the Penninic Rechnitz Series is the deepest tectonic unit in the surveyed area, overthrusted by the Lower East Alpine units Wechsel- and Grobgneiss Series.

As shown in table 2 maximum values of 4000 m/sec and more may be due to either rocks of Grobgneiss- and Wechsel Series or dense limestones and serpentinites of the Rechnitz Serie. Great variations of longitudinal velocity were observed in the Rechnitz Serie but generally the velocities are smaller than in the overlaying tectonic units. This fact may give a "blind zone" in seismic refraction measurements.

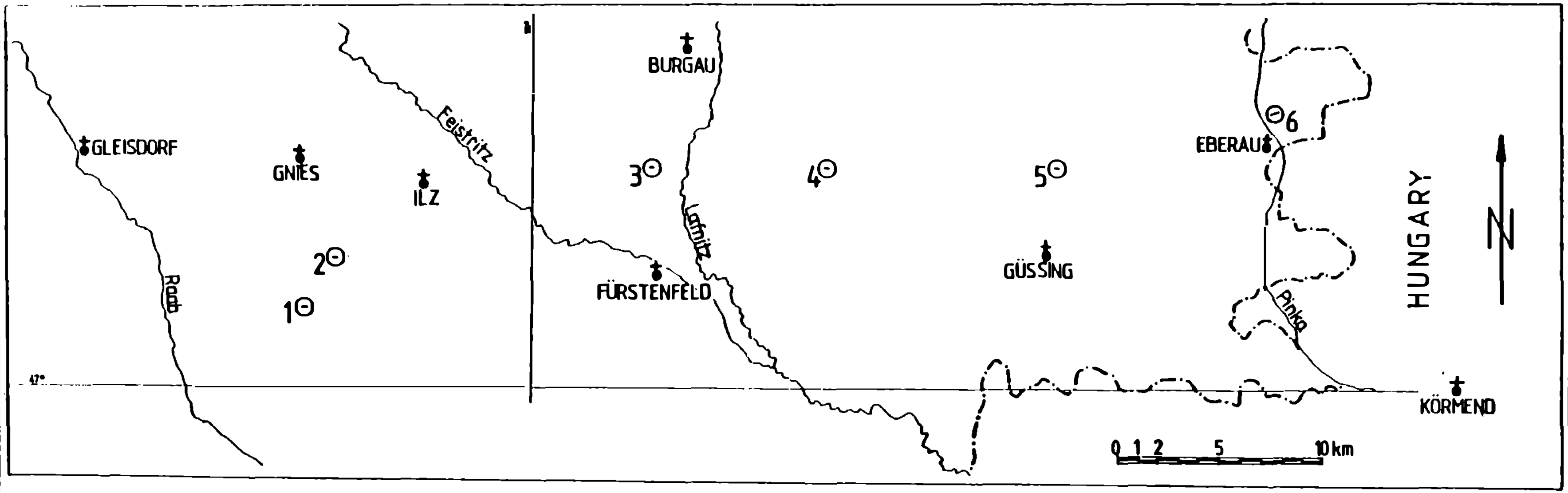
5. Reflection Seismogramms from Shotpoint F (Hungary) Recorded in Eastern Austria.

Three shots from shotpoint F (32 km NE Körmend, Hungary) were recorded by reflection seismic stations on six locations in the eastern most part of the Alpine Longitudinal Profil 1975 (Fig. 8). Besides the analog seismic stations of the Institutes of Geophysics of the universities in Leoben and Vienna a digital reflection seismic station of PRAKLA-SEISMOS GmbH. (working for RAG, Vienna) was also available in 1977.

Date	Time	Charge (tons)	Refl. seism. Station	Location
17. 9. 1975	09 : 01 : 01.95	4	4 (Inst. Leoben)	Eisenhüttel
21. 6. 1977	05 : 00 : 00.57	1	1 (PRAKLA-SEISMOS)	Hartmannsdorf
21. 6. 1977	05 : 00 : 00.57	1	3 (Inst. Leoben)	Commende Wald
24. 6. 1977	05 : 59 : 58.55	2	2 (PRAKLA-SEISMOS)	Eichberg
			5 (Inst. Leoben)	Punitzer Wald
			6 (Inst. Vienna)	Eberau

One of the presented records was taken in 1975 near Eisenhüttel (station 4). The result of a preliminary interpretation was presented in Salzburg (Geodynamic and Geotraverses around the Alps, meeting 28. 2. — 1. 3. 1977). A good agreement between the recorded and theoretical traveltimes was reached by using a compressed and somewhat simplified velocity depth distribution proposed by H. MILLER (1977) for the Tauern Window-area (shotpoint D).

This velocity depth function — further simplified — was used again for the reinterpretation in connection with the 1977 measurements. To fit the theoretical and measured travel times of the headwave M 1 travelling along the bedrock of the Tertiary basins in Austria and Hungary and to simplify the calculations a mean basement depth H 1 was chosen individually for each seismic station. Deriving from this conception the presumable basement depths at the seismic stations an agreement with the so far known topography of the bedrock at least in the Styrian basin has been found. So the computation procedure regarding the individual mean basement depths seemed to be an acceptable interpretation method and it was used also for the later arrivals of reflection and refraction waves.

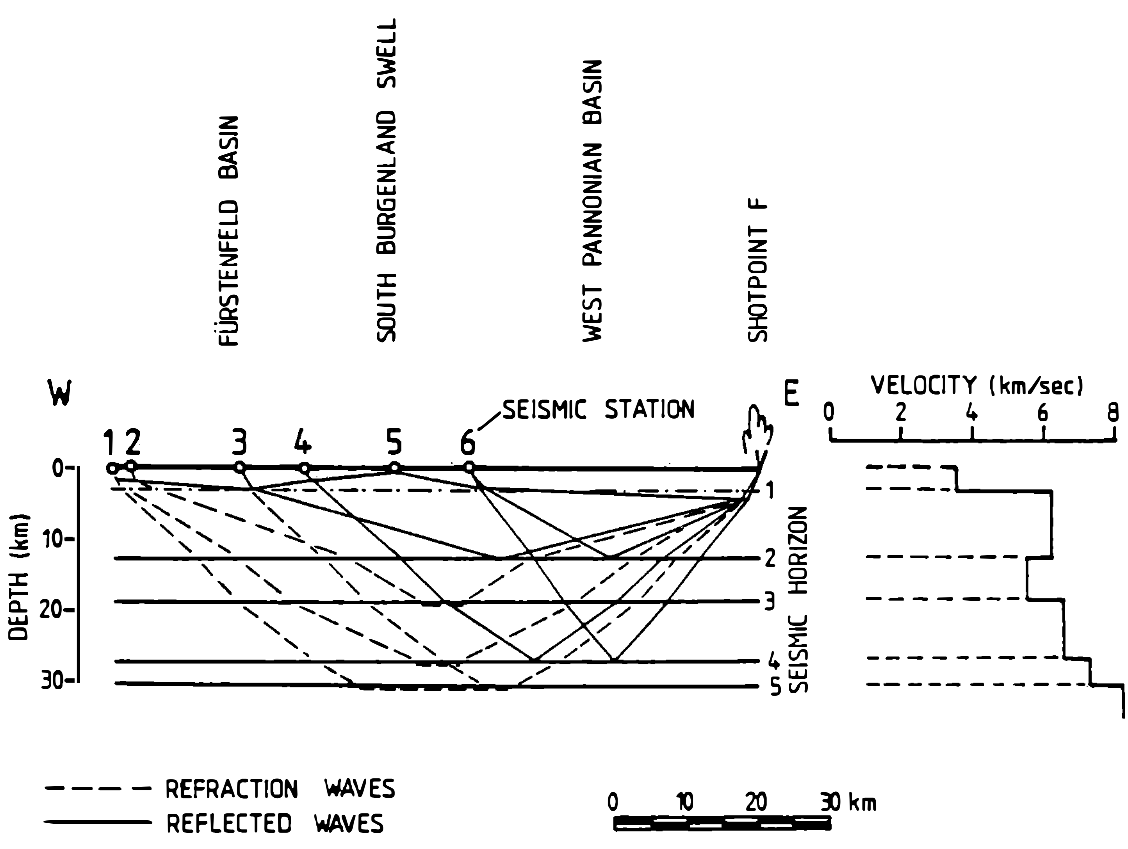


G E O D Y N A M I C   P R O J E C T

POSITION MAP OF THE REFLECTION SEISMIC STATIONS IN AUSTRIA FOR SHOTPOINT F (~32 km NE KÖRMEND, HUNGARY)

Stations	Spread length
1 Hartmannsdorf	1380 m
2 Eichberg	1380 m
3 Commende Wald	690 m
4 Eisenhüttl	690 m
5 Punitzer Wald	690 m
6 Eberau	460 m

Fig. 8: Position map of the reflection seismic stations in Austria for shotpoint F (32 km NE Körmend, Hungary)



REFLECTION SEISMIC STATION

1 HARTMANNSDORF
2 EICHBERG
3 COMMENDE WALD
4 EISENHÜTTL
5 PUNITZER WALD
6 EBERAU

GEODYNAMIC PROJECT

SELECTED RAYPATHS BETWEEN SHOTPOINT F (NE KÖRMEND) AND THE REFLECTION SEISMIC STATIONS ON THE ALPINE LOGITUDINAL PROFILE IN THE MOST EASTERN PART OF AUSTRIA

Fig. 9: Selected raypaths between shotpoint F (NE Körmend) and the reflection seismic stations of the Alpine Longitudinal Profile in the most Eastern part of Austria

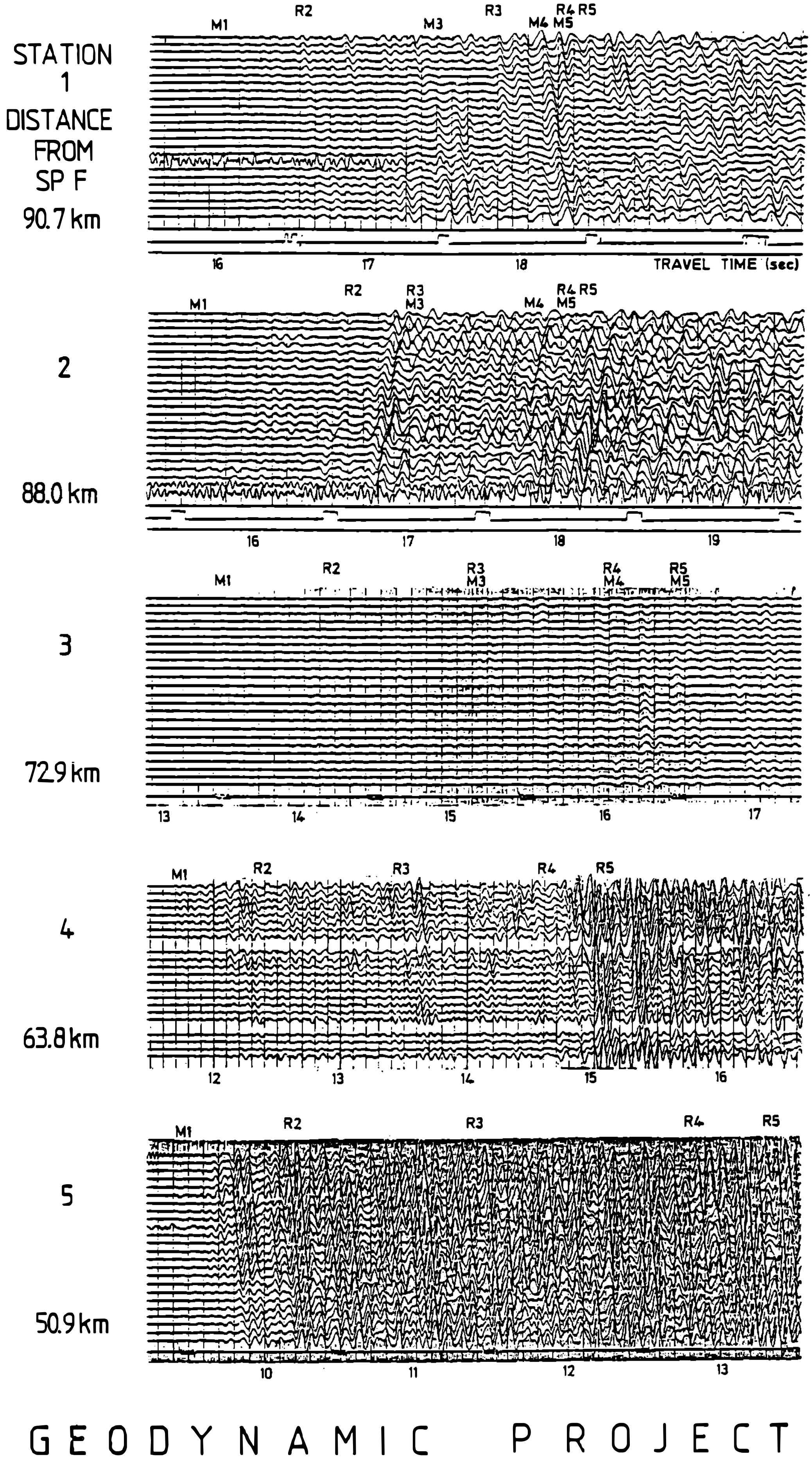


Fig. 10: Reflection seismic records of station 1 to 5 from shotpoint F

Fig. 9 shows the model and some of the theoretically calculated P-wave rays (solid lines for the reflected waves, dashed lines for the refraction waves). The records of station 1 to 5 are presented in Fig. 10. The calculated arrival times of the refraction waves (or Mintrop waves) are marked by M 1, M 2 etc. and the reflection waves are marked by R 2 etc. The position of H 5 on the record indicates for example the arrival time of the refraction wave travelling along discontinuity 5 of Fig. 9 and the position of R 4 shows the calculated arrival time of the reflection from discontinuity 4.

The points of critical reflection lie between 35 and 41 km for the discontinuities 3, 4 and 5 of the model so that critical reflected waves should be expected on stations 1 to 3. A critical reflection should be recognicable by identical travel times of refracted and reflected waves as e. g. of H 3 and R 3 on station 2. Although R 5 is subcritical with regard to the used velocity distribution it actually has the appearence of a critical Moho-reflection.

We were very much obliged to PRAKLA-SEISMOS GmbH, to the party chief E. PFEIFFER and his operators for their spontaneous cooperation. We are also indebted to RAG Vienna for having taken an interest in this extra activity of the PRAKLA-SEISMOS seismic party.

6. Geophysics Maltern area.

The area around Maltern has been chosen for refraction and reflexion seismic experiments.

The main reason for taking this region was the fact that in this area three tectonic units are situated within a short distance: the Rechnitz Nappe, the Wechsel Nappe and the Grobgneiss-series. Former refraction seismic measurements and the result from a deep well (Maltern I) have been used as a base for the research program

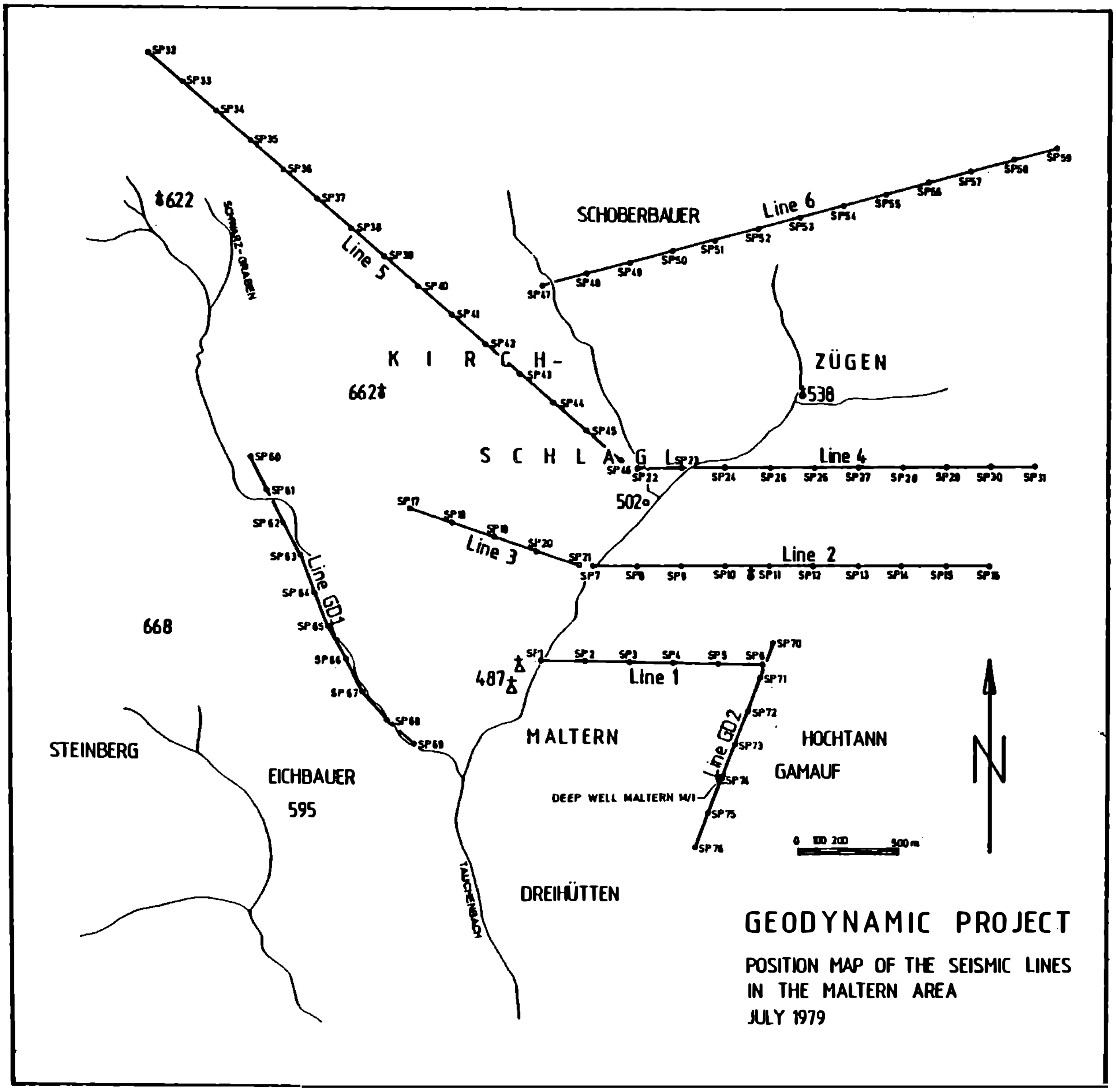


Fig. 11: Position map of the seismic lines in the Maltern area

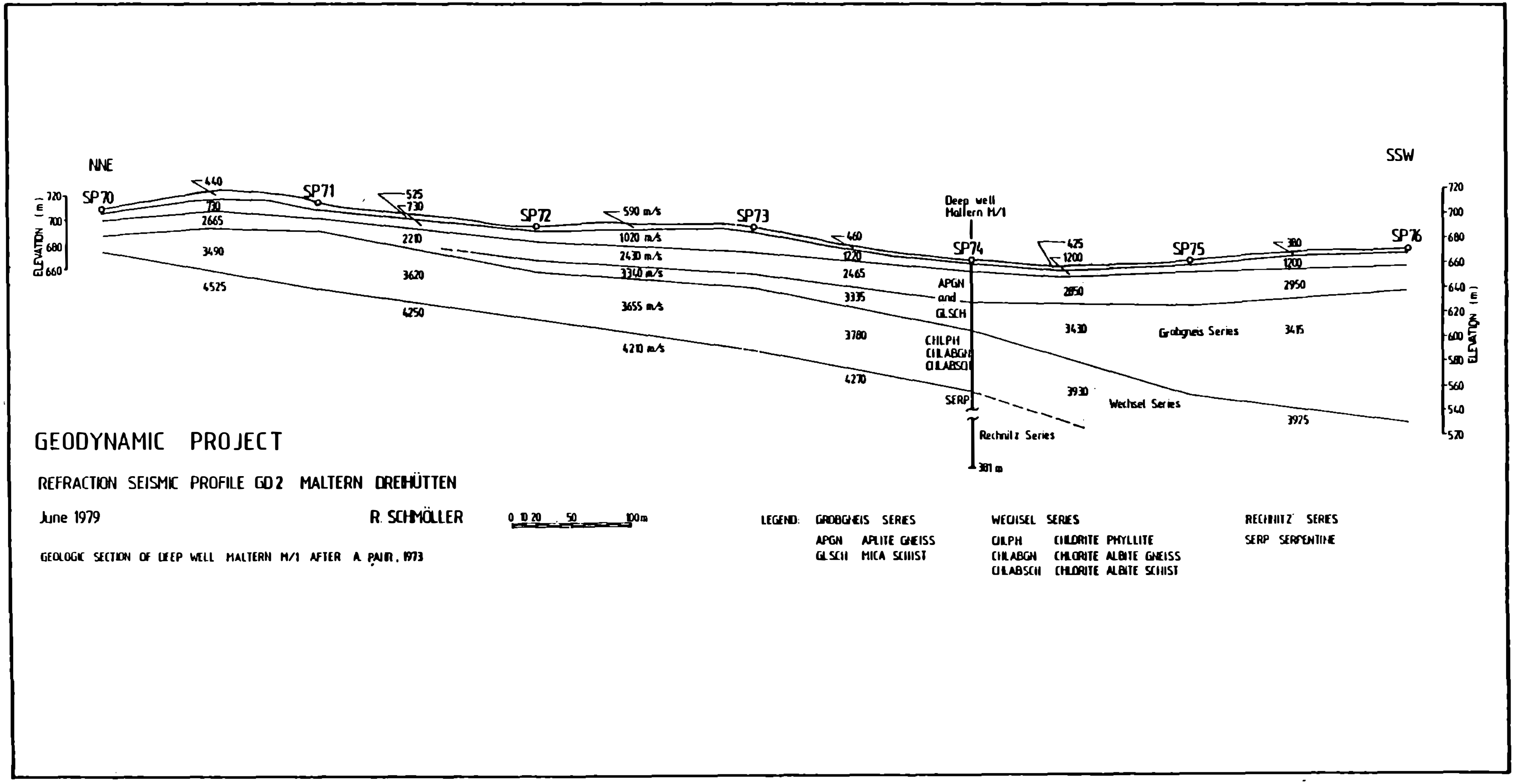


Fig. 12: Refraction seismic profile GD2 Maltern-Dreihütten

of the geodynamic project. A new geological map (A. PAHR) was available for the correlation of the geophysical facts. An area of 20 km² was investigated with 8 refraction seismic lines of 14,1 km length (fig. 11). On two of these lines (line GD 1 and GD 2) additional reflection seismic measurements have been carried out.

The seismic methods are normally used in sedimentary areas and research works in crystalline areas are rare, due to the difficulty in analyses of the data. One basic problem is the determination of marker horizons. Despite these difficulties some positive aspects were found from an older investigation in the metamorphic rocks near Schlaining (15 km in the SE). The seismic data gave indication to the trends of tectonic features and relatively flat lying structures, in agreement with the geological evidence that the Grobgneiss-series is a relatively thin, flat lying cover.

Interpretation problems and results.

Severe problems often arise from the weathering layer, and its influences must be correctly eliminated. This is especially important for finding smaller structures (faults, tectonic lines) in crystalline areas combined with decreasing velocities. Multiple coverage is a necessity and gives a better velocity control.

Computation methods based on a successive reduction of the multiple-layer case are appropriate. Since they give a good insight into each step of the interpretation. A trial and error procedure is often useful in complicated cases. Nevertheless depth control is not as good as in sedimentary areas.

The southern part of the area is of particular importance for the interpretation because there is a connection of the seismic lines with the well Maltern 1. The line GD 2 gave a good insight into the problems of analyses and interpretation (fig. 12). This line confirms the experience, that velocities of rocks measured in situ are often much lower than the laboratory determinations of ultrasonic velocities. Generally there are up to 6 layers on this profile. The most important result is that the Grobgneiss-series, the Wechsel-series and the serpentinite of the

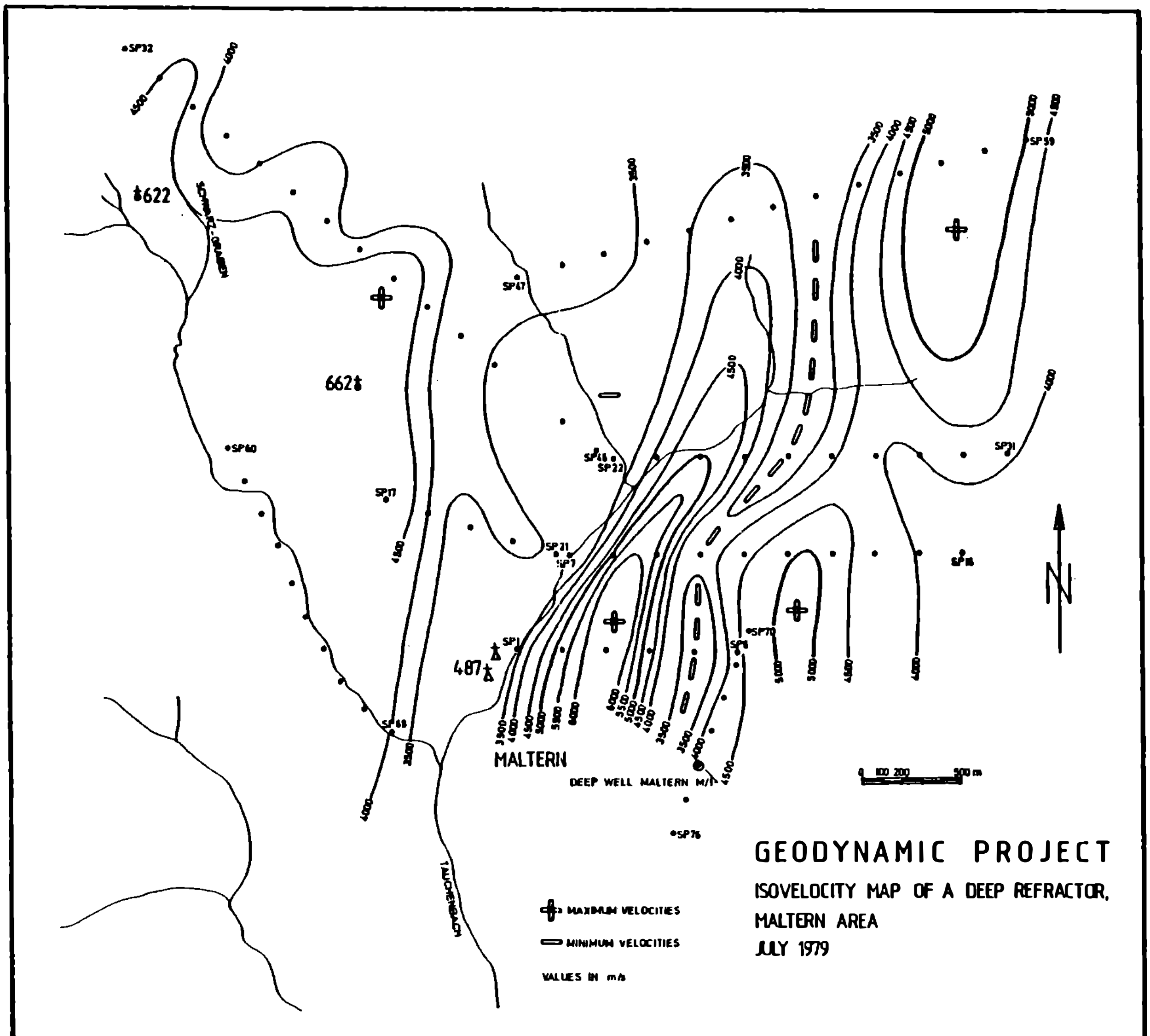


Fig. 13: Isovelocity map of a deep refractor, Maltern area

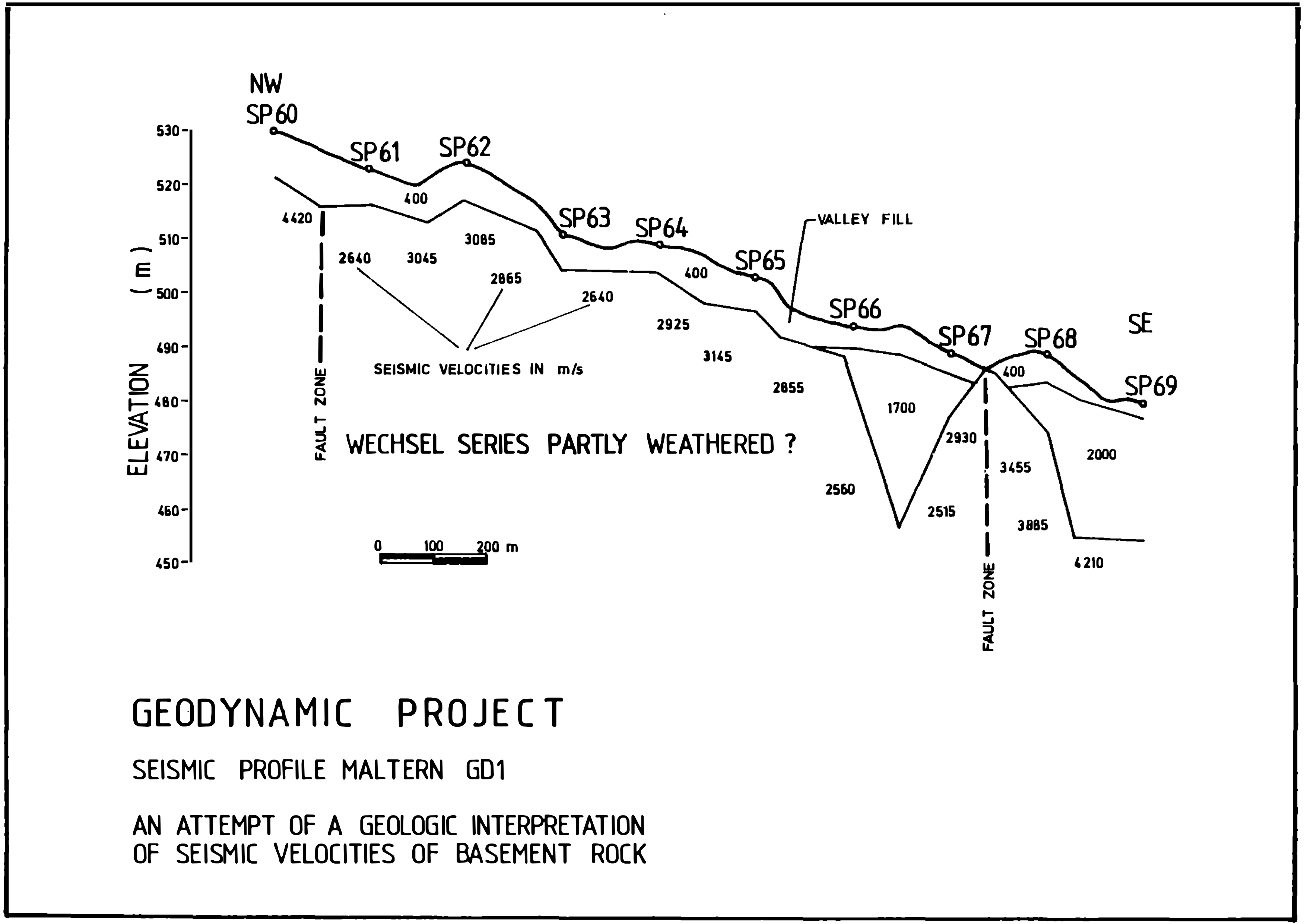


Fig. 14: Seismic Profile Maltern GD 1

Rechnitz-series could be recognized by special marker horizons. The nappe structure of this area is proven by the well and the profile indicates flat lying overthrusting.

The gneisses and micaschists of the uppermost Grobgneiss series have relatively low velocities (up to 3430 m/sec) which is partly due loosening of the rock structure. The velocities of the Wechsel-series are between 3500—3930 m/sec and there is a clear velocity decrease to the north. The deepest refractor has velocities between 4210—4520 m/sec and is correlated with the top of the serpentinite body. All the refractors show a flat rise in the northern direction which leads to the conclusion that the geological horizons and discontinuities have the same tendency. The deepest refractor — the serpentinite — could be found on most seismic lines and be correlated in the S and E part of the investigation area. Velocities of this marker horizon are up to 6000 m/sec.

An attempt was also made to construct an isovelocity map of the deepest refractor (fig. 13). This map shows 4 maximum areas (velocities > 4500 m/sec.). These structures are situated in the serpentinite of the Rechnitz-series and in the Wechsel-series. A pronounced minimum zone in the eastern part has a N-NNE strike direction and may indicate a tectonic feature. The Tauchen valley near Maltern seems also to be a fault zone charactericed by a zone of minimum velocities. The exact proof of a fault and its displacement is more difficult as in an area with sedimentary horizons. Often a combination of different facts can be used to locate such tectonic elements (fig.14). A detailled correlation of these elements gives a picture whereby a probable solution is a series of generally N-NNE striking fault zones (fig. 15). The serpentinite body seems to culminate south of line 2 and may be bounded by faults to the east and west. In the Tauchenbach area a graben like structure is assumed.

The corrected travel time of refraction time-distance curves often show small anomalies caused by irregularities of the weathering layer and the relief of the crystalline horizons. The velocity-depth distribution shows normally a 4-layer case. The V_1-horizon (600—700 m/sec) is due to the top soil and the V_2-horizon (1500—2000 m/sec)

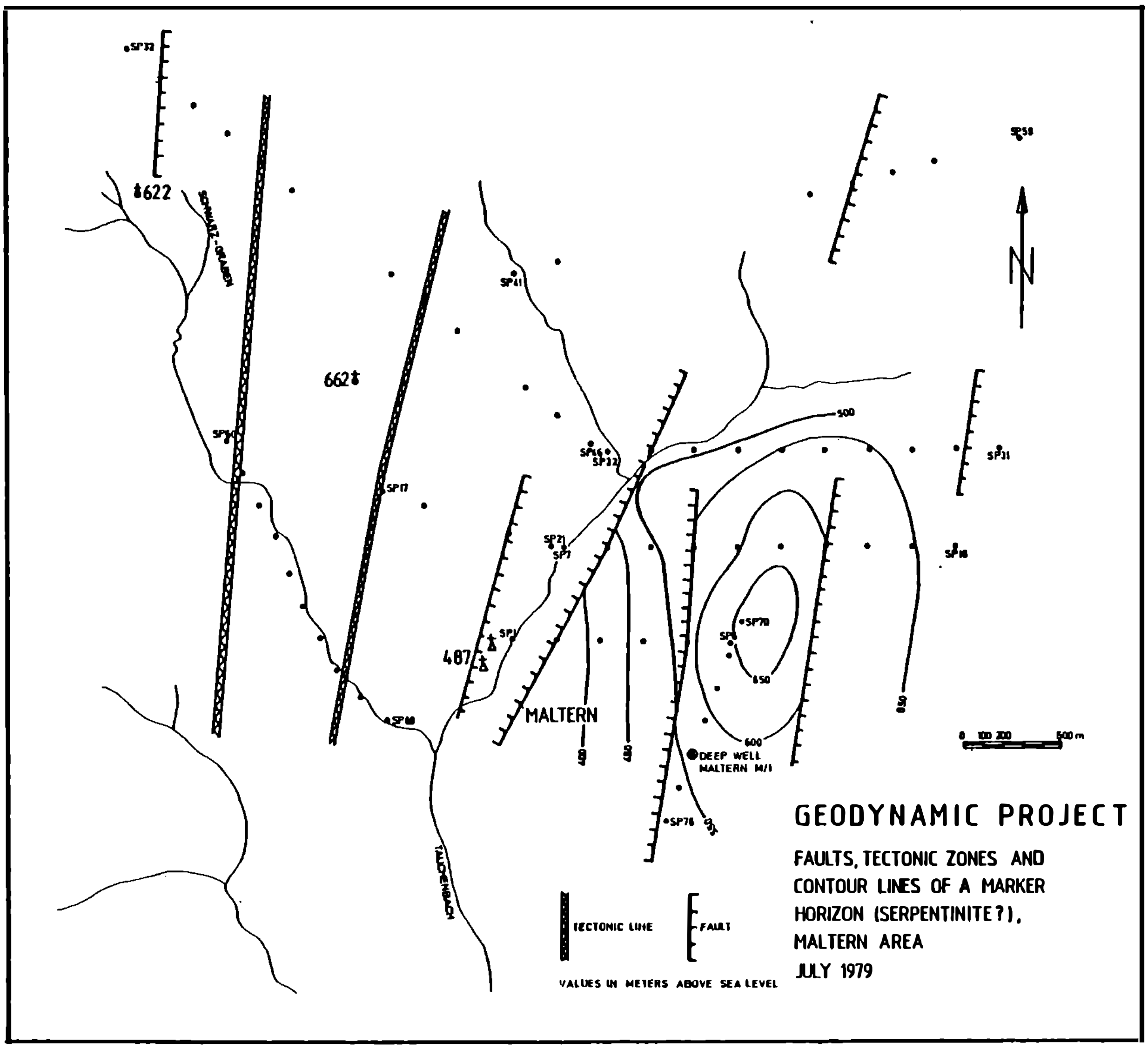


Fig. 15: Faults, tectonic zones and contour lines of a marker horizon (Serpentinite?), Maltern area

corresponds to the weathered crystalline rock. The V_3-horizon with velocities > 3000 m/sec reflects the normal velocities of the various metamorphic series. The V_4-horizon is charactericed by high velocities (>4000 m/sec) and may be due to serpentinites or gneisses (Table 2).

In connection with a refraction seismic survey in the Maltern area in 1977 experimental reflection seismic measurements were carried out to see if the reflection seismic method could give additional informations about the complicated layering of the various geological units.

From geological considerations and refraction seismic measurements a rather flat and shallow layering of the Rechnitz-, Wechsel- and Grobgneiss-series are evident. Therefore reflection seismic travel times between 200 and 300 msec were expected from the interfaces of these tectonic units. Small charges had to be used to prevent making these shallow reflection signals by ground roll energy. Hence only shallow holes were necessary which was also of an economic importance.

The velocities obtained from the refraction seismic measurements and the reflection arrivals observed at approx. 300 msec on seismic line GD 1 indicate some major discontinuity at a depth of 550 to 600 m, which is possibly the interface between the Rechnitz- and Wechsel-series.

On seismic line GD 2 reflection arrivals at 200 msec apparently come from the base of the serpentine rock. In this area the serpentine represents the top of the Rechnitz-series (350—400 m).

A clarification of the layering of the various geological units by the reflection seismic method seems questionable, especially with the available equipment and realizable fieldtechniques. However using sophisticated outfit and operation techniques in combination with adequate data processing is beyond the scope of realistic exspectations at the present time, due mainly to the high costs.

7. Geothermics.

Geothermal investigations are the base for a model of the thermal state at the easternmost part of the Alps and are of some importance for the solution of the geodynamic problems.

Temperature measurements are missing in this area and data only exist from the surrounding East Styrian Basin and an uplifting ridge ("Burgenländische Schwelle"). The data are from different sources, wild cat wells of the oil exploration, measurements in artesian water wells, underground temperature measurements in mine shafts (table 3).

Table 3: Temperature measurements in wells

	Depth m	Maximum Depth of Measurement m	Depth Interval of Measurement m	Vertical Temperature Gradient °C/m	Temp. Step. m/°C
Übersbach 1	2694	2694	0—1000	0,0449	28,6
Walkersdorf 1	2143	2143	0— 700	0,0442	22,6
Binderberg 1	1725	1725	0—1410	0,0529	18,9
Litzelsdorf 1	2439	2439	0—2439	0,0400	25,0
Schönau 1	269	145	65— 135	0,0229	43,6
Schönau 2	396	290	90— 205	0,0228	43,7
			245— 290	0,0253	39,5
Grafendorf	182	167	55— 167	0,0379	26,4
Penzendorf	143	143	120— 143	0,0400	25,0
Großsteinbach	120	120	60— 110	0,0534	18,7
Blumau	85	85	55— 85	0,0446	22,4
Eggendorf	89	89	55— 90	0,0420	23,8
Hatzendorf	53	53	15— 53	0,0429	23,3
Feldbach	129	129	65— 129	0,0307	32,5

The data from the deep wells are bottomhole temperature measurements. Their correction for the influence of mud circulation etc. was difficult. Only in the well Litzelsdorf 1 (ÖMV-AG) a continuous temperature log was run.

In the area of the Rechnitz unit there exist measurements from 2 holes, drilled for mineral exploration and from an antimonite mine [1]. All the values are in the same order of magnitude, a mean value for the vertical temperature gradient of 0,024°C/m is assumed.

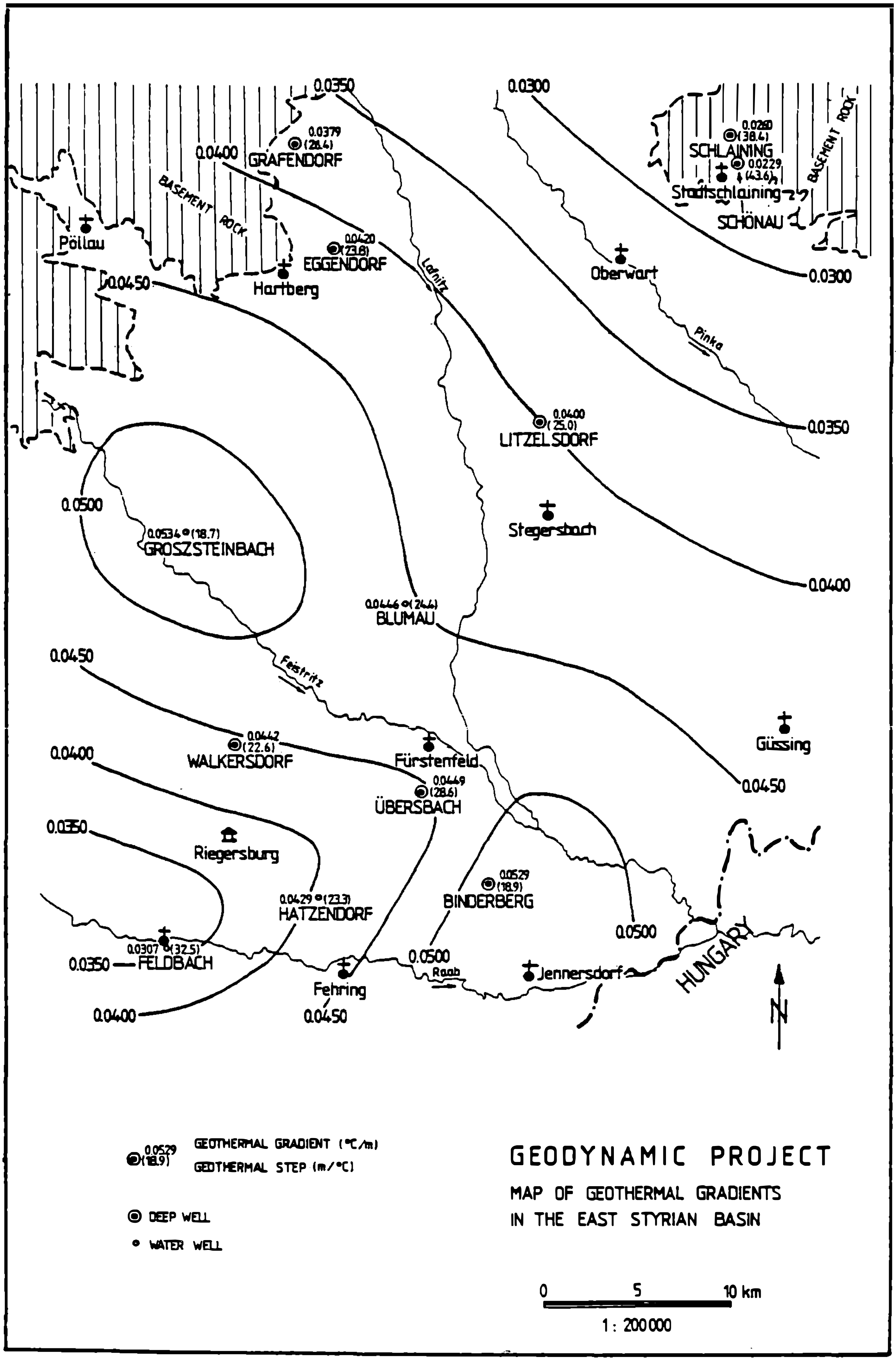
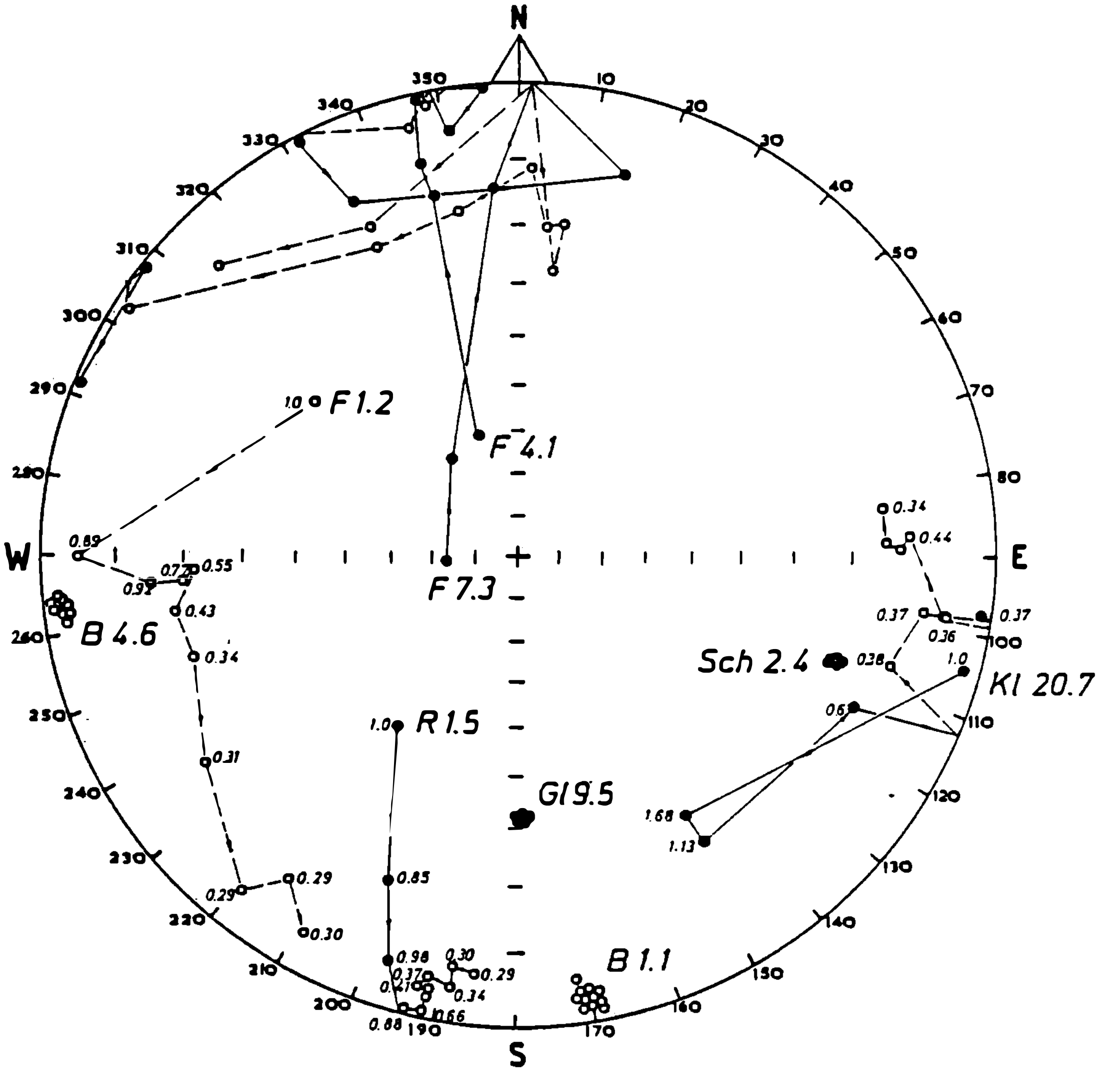


Fig. 16: Map of geothermal gradients in the East Styrian Basin

All the deep wells in the East Styrian basin have a vertical temperatur gradient which is higher than the normal value (F. WEBER 1975). The same results were got from measurements in water wells up to a depth range of 180 m. The map of vertical temperature gradients (fig. 16) is valid for the depth range of at least 500 m. A zone of maximum values is situated N of Jennersdorf, changing in a NW direction in its northern continuation. Another maximum is only represented by the high gradient in the well Großsteinbach (0,0534°C/m). A geological remarkable result is the fact, that in the uplift of the Rechnitz schists a relatively low gradient exists.

8. Palaeomagnetic Investigations on Basalts and Andesites from the Eastern Alps.

A large suite of samples from the Miocene (Gleichenberg, Schaufelmühlgraben and Birkenblösse) and the Pliocene (Klöch, Gnas, Fehring and Riegersburg) volcanic series were collected for palaeomagnetic investigations. Rockmagnetic experiments were carried out on a number of pilots and in most cases magnetite and titanomagnetite was established as carrier of the remanence (NRM).



Stabilitytest of the direction of the NRM

0 to 900×10³/4π A/m

Fig. 17: Stabilitytest of the direction of the NRM

Table 4: Table of the Palaeomagnetic Results

Nr.	Locality	Rocktype	Age	CaRM		Treatm.	N	k	95	Poleposition	
				P_{Dec}	P_{Inc}					P_{Lat}	P_{Long}
1	Weitendorf	basalt (shoshonit)	miocene (14 My)	060.0	+30.0	400 Oe	10	37	5.3		
2	Mühldorf	basalt	pliocene	015.0	+30.0	400 Oe	27	26.6	5.31		
3	Hochstraden	basalt	pliocene	200.0	—60.0	400 Oe	52	88	2.0	74.0	85.1 E
4	Klöch	basalt	pliocene	260.2	—53.0	700 Oe	20	2.1	30.9	30.1	87.2 E
5	Gleichenberg	andesite	miocene	341.9	+68.5	700 Oe	9	64.3	6.5	77.2	315.2
5	Birkenblösse	trachiandesite	miocene	014.6	+77.6	700 Oe	4	317.2	5.2	69.0	32.4 E
5	Schaufelmühlgraben	quartztrachite	miocene	347.7	+69.0	700 Oe	3	686.9	4.7	66.1	104.8 E
6	Gnas	tuffite	pliocene								
7	Fehring	tuffite	pliocene								
8	Riegersburg	tuffite	pliocene	272.1	—19.9	700 Oe	1	4.9	30.3	06.1	97.0 E
	Kollnitz	basalt	miocene	339.9	+76.0	400 ° C	15	21.7	8.3	69.7	348.7

In some Miocene material where the NRM is hard a strong influence of hematite was observed. The presence of hematite was proven by microscope analysis and demagnetisation experiments. Whereas the magnetisation in the basalts and andesites after the cleaning of the viscous remanence became stable, the tuffites of Gnas and Fehring were unstable. Hence these tuffites are unsuitable for palaeomagnetic purposes (fig. 17). The tuffite of Riegersburg shows a good example of multicomponent behaviour and seems to be stable above $700 \times 10^3/4\pi$ A/m. Nevertheless the poleposition doesn't agree with any known Neogene poleposition. One has, therefore, to think of very deep reaching weathering effects and a bad grouping of the coarse grains during sedimentation.

The samples from the Klöch locality were taken in different parts of the northern quarry where there was the best chance of getting unweathered material. The volcanic sequence consists of columns overlain by tuffites and massive basaltflows. No difference in the magnetic behaviour was found between these different flows. The grouping within a site scatters from α 95 = 4.0 to α 95 = 32.0°. A few sites lie in the opposite quadrant,

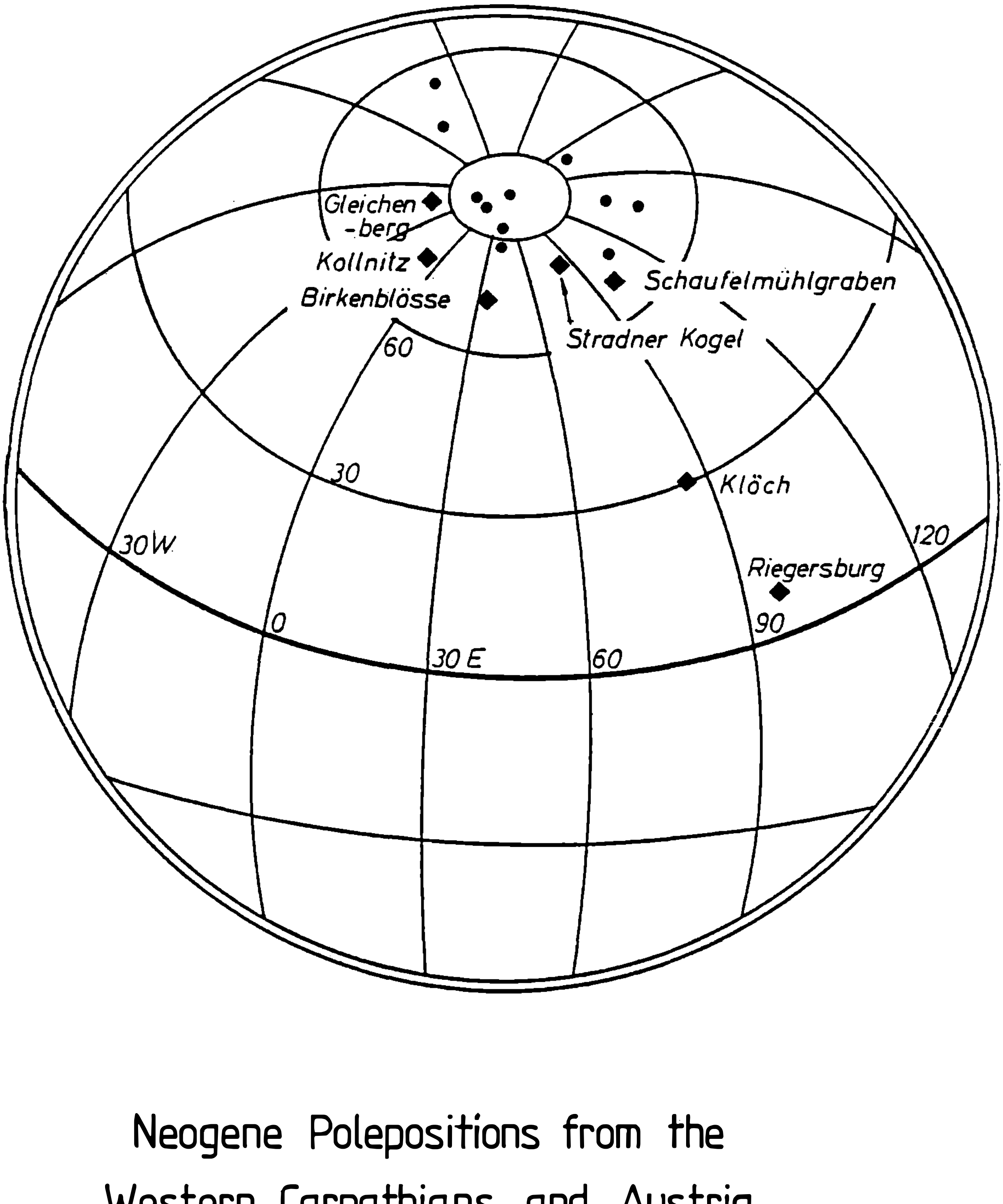


Fig. 18: Neogene polepositions from the Western Carpathians and Austria

compared to that of the majority of sites, with negativ inclinations so that one has to think of intensive movements within the lavaflow after cooling below the curie point. The overall mean-direction for Klöch shows very poor statistical parameters, therefore, the calculated poleposition was bad as expected (Table 4). The pole at this present stage is meaningless (fig. 18) and calles for more detailed fieldwork in the future. A very good grouping of the NRM was found in the trachiandesite samples taken from the Miocene sequence of Birkenblösse near Gleichenberg. The pilots showed a high stability (fig. 17) and the whole material was AC-cleaned at 700 x $10^3/4\pi$ A/m. The mean direction is well defined and allowed the calculation of a Miocene poleposition.

Quartztrachite was sampled in the Schaufelmühlgraben and again a high stability of the NRM was found (fig. 1). Of all the sampled Miocene localities, the statistical parameters are the best here (Table 4). The whole material was cleaned at 700 x $10^3/4\pi$ A/m.

To the north of Gleichenberg, fresh andesite and trachiandesite outcrops in the new part of a quarry were sampled and pilots confirmed a high stability of the NRM (fig. 17). For all Miocene localities the paleopoleposition was calculated as mentioned before and compared with polepositions from Austria and Czechoslovakia. One can see, that the agreement is quite good. Only the position of the Birkenblösse indicates a steeper inclination than the others. The reason seems to be a local tectonic complication. The same reason could be the cause for the slight clockwise deviation of the Schaufelmühlgraben.

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