PUBLICATION OF THE NETHERLANDS GEODETIC COMMISSION

GEODETIC WORK

IN

THE NETHERLANDS

1967—1970

Report prepared for the General Assembly of the International Association of Geodesy, XVth General Assembly of the International Union of Geodesy and Geophysics, Moscow, 1971

1971

Rijkscommissie voor Geodesie, Kanaalweg 4, Delft, The Netherlands

1 GEOMETRIC GEODESY

1.1 **Primary triangulation**

1.1.1 *Base extension net Afsluitdijk*

In 1967, the stations Stevinsluizen, Eierland, Sexbierum and Burgwerd, forming part of the base extension network of the new base "Afsluitdijk", were remeasured. This work was considered necessary since remeasurement of the three other stations, Lorentzsluizen, Workum and Staveren (carried out in the autumn of 1966, see Geodetic Work in The Netherlands, 1963–1966, pp. 1–2), had given very little improvement.
At the stations Stevinsluizen, Eierland and Burgwerd, where the directions to be measured pass over a homogeneous surface, the method of Schreiber was applied for the remeasurement in order to speed up the observations. The original observations were made by the method with reference mark. Combining the new observations with the previous ones gave a better elimination of the influence of lateral refraction, as could be expected, resulting in satisfactory final results.

A report on the base Afsluitdijk and the extension net is under preparation. It will be published in 1971 by the Netherlands Geodetic Commission.

1.1.2 *New triangulation net around the former Zuiderzee*

Check measurements at triangulation stations in Noord-Holland showed larger discrepancies than in other parts of the country. The reason must be sought in a lowering of the water-table in this region after the dam between Noord-Holland and Friesland (Afsluitdijk) was built with the result that the near-surface peat layers became more consolidated. Since a new triangulation net is presently being measured around the former Zuiderzee, it has been decided to include in this new net the old primary stations in addition to the new stations that replace the lost old first order points in this part of the country. About half the number of observations for this new net were completed by the end of 1970.

1.1.3 *Publications*

BAKKER, G. – The Adjustment of Primary Direction Measurements with Special Reference to Circle Testing Methods, Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 3, No. 2, Delft, 1970 – 42 p., 3 fig.

1.2 Electromagnetic distance measurement

1.2.1 *General*

When measuring the above mentioned base extension network, experiments were carried out to test the distance-ratio method of Prof. Ir. W. BAARDA*. A MRA 4-tellurometer was used for these experiments.

1.2.2 *High precision traverse Malvern-Graz*

In accordance with the resolutions adopted at the A.I.G.-symposium at Paris (February, 1969) and the subsequent meeting at Munich (November, 1969), a start was made with electromagnetic distance measurements between the satellite stations at Brussels and Delft.
In 1970 the traverses S. Maria Oudenhove–Kester, Kester–Asse, Asse–Waasmunster, Waasmunster–Axel and Axel–Kloetinge were measured with a MRA 4-tellurometer while the first two distances were also measured with a laser-geodimeter. The measurements on Belgian territory were carried out in collaboration with the Institut Géographique Militaire in Brussels. It was planned to complete the whole programme before the end of 1970 but a serious breakdown of the tellurometer forced to stop the observations. The five remaining distances, Kloetinge–Zierikzee, Zierikzee–Goedereede, Goedereede–Monster, Monster–Delft and Delft–Ypenburg (satellite station) will now be observed at the beginning of the 1971 measuring season.
For correcting the tellurometer observations, use was made of a new resistance-psychrometer to measure temperature and humidity. As the thermometers are hung a few metres away from the towers, it is expected that this apparatus will yield more reliable results. However, the observations have not been analyzed yet.

1.2.3 *Publications*

MUNCK, J. C. DE – The Theory of Dispersion Applied to Electro-Optical Distance Measurement and Angle Measurements. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 3, No. 4, Delft, 1970 – 48 p., 1 fig.

1.3 Remeasurement of the standard base "Loenermark"

1.3.1 *General*

At the request of the Netherlands Geodetic Commission, the base Loenermark was remeasured by the Finnish geodesists Dr. T. HONKASALO and Mr. P. GRÖHN in the autumn of 1969. For this remeasurement the same method and the same equipment was used as for the original measurements, carried out by Dr. T. J. KUKKAMÄKI and Dr. T. HONKASALO in 1957. The remeasurement gave the following results:

	distance		difference	standard deviation
	1957	1969		
first half	288051.93 mm	288052.33 mm	+0.40 mm	0.03 mm
second half	288040.93 mm	288041.13 mm	+0.20 mm	0.03 mm
total length	576092.86 mm	576093.46 mm	+0.60 mm	0.04 mm

* BAARDA, W. – Statistical Concepts in Geodesy. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 2, No. 4, Delft, 1967.

1.3.2 *Publications*

HONKASALO, T. – Remeasurement of the Standard Base Loenermark. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 4, No. 2, Delft, 1971.

1.4 Triangulation and trilateration Hydrographic Office Royal Netherlands Navy

1.4.1 *The Netherlands*

The existing primary and secondary triangulation is the geodetic framework for hydrographic surveys in the estuaries and inshore work. For offshore areas, horizontal control for bathymetric work is obtained by electronic position fixing systems, such as the Decca Navigator.
In cooperation with the United Kingdom a Decca Hi-Fix system, covering the southern part of the North Sea has been established to obtain higher accuracies. In each of the two countries – U.K. and The Netherlands – two transmitting stations are located. The coordinates of all four stations are based on the European Datum (first adjustment).

1.4.2 *Surinam*

The extensive hydrographic and oceanographic surveys of river estuaries, coastal waters and the continental shelf of Surinam have been completed. For these surveys horizontal control was obtained by a Decca Survey Chain, except for rivers and estuaries, where horizontal control was based on third order triangulation.

1.4.3 *Netherlands Antilles*

In 1970 extensive hydrographic and oceanographic surveys around the Netherlands Antilles have been started. These surveys are expected to be finished by the end of 1972.
During 1970 a Decca Survey Chain with transmitting stations on the islands Aruba, Curaçao and Bonaire has been used for horizontal control. The coordinates of the Decca stations are based on the "Provisional South American Datums" by making use of the I.A.G.S. Triangulation system. Transformation formulae to transform local grid coordinates into I.A.G.S. (UTM) coordinates have been developed.

1.4.4 *General*

Trials with the long range "Omega" navigation system and with a satellite navigation receiver have been made.
In 1970 an automated data logging and processing system has been installed on one of the surveying vessels. The system is being evaluated.

1.4.5 *Publications*

RAASVELDT, G. D. – Hydrographic Survey of Surinam. The International Hydrographic Review, Vol. XLV, No. 1, pp. 47–53, Monaco, 1968 – 7 p., 7 fig.
GENT, W. G. VAN – The Surinam Traverse. The International Hydrographic Review, Vol. XLVI, No. 1, pp. 7–16, Monaco, 1969 – 10 p., 5 fig.

LANGERAAR, W. – Towards an International Chart. The International Hydrographic Review, Vol. XLVI, No. 2, pp. 7–16, Monaco, 1969 – 10 p.

OPSTAL, L. H. VAN – Report on Testing Omega Navigation Receiver Tracor Type 7007. Netherlands Hydrographic Office, Hydrographic Newsletter, Vol. 2, No. 3, pp. 175–199, The Hague, 1970 – 25 p., 10 fig.

GENT, W. G. VAN – A Small Computer Method for the Conversion of Spheriodal Hyperbolic Coordinates into Geographic Coordinates. Netherlands Hydrographic Office, Hydrographic Newsletter, Vol. 2, No. 3, pp. 207–215, The Hague, 1970 – 9 p., 3 fig.

1.5 Computing Centre, Geodetic Institute, Delft University of Technology

1.5.1 *General*

In the report period a free adjustment of the primary triangulation net, i.e. an adjustment without Laplace- and base conditions, was executed. The precision of the net was thoroughly examined and the observations were checked by means of statistical tests (see coloured map at end of this report). The computed coordinates of boundary stations were compared with those obtained from the German and Belgian computations.

The reduction of the matrix of normal equations of this net for the connection with other countries was completed. The connection with the Belgian net was executed both in Brussels and at Delft; the results have been compared.

Continuation of the computations awaits the completion of the planned Laplace azimuth observations.

1.5.2 *Publications*

ALBERDA, J. E. – Decision-Making and Surveying. Paper presented at the 12th F.I.G.-congress, London, 1968. Archives of the Twelfth International Congress of Surveyors, Volume B, pp. 507 8 – 507 14, London, 1969 – 7 p., 2 fig.

BAARDA, W. – A Testing Procedure for Use in Geodetic Networks. Report SSG 1.14 presented at the 14th A.I.G.-General Assembly, Lucerne, 1967. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 2, No. 5, Delft, 1968 – 97 p., 20 fig.

BAARDA, W. – Statistics: A Compass for the Land Surveyor. Paper presented at the 12th F.I.G.-congress, London, 1968. Archives of the Twelfth International Congress of Surveyors, Volume B, pp. 507 15 – 507 26, London, 1969 – 12 p., 4 fig.

KRUIF, J. C. P. DE – The Adjustment of the Primary Triangulation of The Netherlands. Report presented at the symposium on the New Adjustment of the European Triangulation, Paris, 1969. Commission Permanente Internationale des Triangulations Européennes. Publication No. 7, pp. 43–61, Munich, 1969 – 19 p., 8 fig.

2 LEVELLING AND MOVEMENT OF THE EARTH'S CRUST

2.1 **Precise levelling**

2.1.1 *General*

The hydrostatic measurements for a levelling network covering the whole country were continued. This network will consist of a series of concatenated hydrostatic levellings in the canals and rivers of the Netherlands. The 7 km long lead pipe needed for this operation is laid out and taken up again by a specially equipped ship.
During the report period 887 km of this levelling were completed. The average length of one hydrostatic measurement was 5.25 km, the number of measurements amounts to 169.
By the end of 1970 three circuits were completed with the following preliminary results.

circuit no.	length	misclosure
1	429.2 km	−25.9 mm
2	420.0 km	+ 2.8 mm
3	453.9 km	+ 8.3 mm

These circuits cover the whole country. The measuring of a hydrostatic levelling line through the northern part of Belgium would allow a fourth circuit to be added to the network.
To connect the hydrostatic levelling network to underground benchmarks a series of short first-order levelling lines were measured. The total length of these levellings made during the period of reporting amounts to 396 km. In addition to this, approximately 2400 km of second order levellings were carried out for various purposes.

2.1.2 *Instruments*

For first order levelling work the automatic instruments Zeiss Ni-2 and Jena Koni 007 were used.

2.1.3 *Methods*

The methods employed are the same as those described in the reports presented in Toronto (1957) and Helsinki (1960).

2 1.4 *Datum of the network*

The datum of the network is Normaal Amsterdams Peil (N.A.P.), fixed by an underground benchmark at Amsterdam.

2.1.5 *Junctions with contiguous networks*

In 1969 three new connections with the Belgian first-order levelling network were measured in order to improve relative connections between the Belgian and Netherlands datum in the area of the North Sea coast.
The new connections are:

1969	Sas van Gent–Zelzate	$\varphi = 51°12'37''$ N	$\lambda = 3°48'12''$ E
1969	IJzendijke–Watervliet	$\varphi = 51°17'39''$ N	$\lambda = 3°37'36''$ E
1969	Retranchement–Knokke	$\varphi = 51°20'48''$ N	$\lambda = 3°22'40''$ E

In the area between Coevorden and Oldenzaal four connections with the levelling net of Niedersachsen (W. Germany) were measured in 1968 and 1970. The connection at Coevorden is of the first order, the other connections are of the second order:

1970	Coevorden–Agterhorn	$\varphi = 52°38'54''$ N	$\lambda = 6°45'20''$ E
1970	Gramsbergen–Agterhorn	$\varphi = 52°36'57''$ N	$\lambda = 6°43'36''$ E
1968	Hardenberg–Vennebrügge	$\varphi = 52°33'15''$ N	$\lambda = 6°41'07''$ E
1968	Vasse–Uelsen	$\varphi = 52°27'40''$ N	$\lambda = 6°50'12''$ E

2.1.6 *North-West European Lowlands Levelling*

Some additional data were submitted for the final adjustment.

2.1.7 *Special measurements*

Hydrostatic levellings allowing connections to be made between isolated tide gauges at sea and the levelling network on land were continued.

2.1.8 *Publications*

HOUVEN, G. VAN DER – Nauwkeurigheidswaterpassing; ontstaan, instandhouding en vernieuwing. (Precise Levelling in The Netherlands; Origin, Maintenance and Updating). Geodesia, Utrecht, 1968, pp. 45–51 – In Dutch, 7 p.

WASSEF, A. M. and MESSIH, F. Z. A. – Introductory statistical analysis of the second and third precise levellings of The Netherlands (part I).
Travaux de l'Association Internationale de Géodésie, Tome 23, pp. 99–107, Paris, 1968 – 9 p.

WEMELSFELDER, P. J. – Mean sea level as a fact and as an illusion. Paper presented at the Symposium on Coastal Geodesy, Munich, 1970.

2.2 **Movements of the Earth's Crust**

2.2.1 *Measurements*

At the request of the subcommission on Crustal Movements of the Netherlands Geodetic Commission precise levellings were carried out across the saltdomes near Winschoten, Schoonlo and Weerselo (first measurement) and across a number of faults between Venlo and Roermond (various measurements have been made since 1923).
Daily vertical movements of coastal benchmarks were studied in terms of their relationship to the tide by means of hydrostatic levelling at Delfzijl in 1969.

2.2.2 *Publications*

WAALEWIJN, A. – Hydrostatic measurement of vertical movements of the coast in relation to the tide. Paper presented at the Symposium on Coastal Geodesy, Munich, 1970.

3 GEODETIC ASTRONOMY GEOMETRIC STUDY OF SATELLITES

3.1 **Geodetic Astronomy**

3.1.1 *Twin Laplace Point Ubachsberg–Tongeren*

In 1968, astronomical observations were carried out at the primary stations Ubachsberg (The Netherlands) and Tongeren (Belgium) to form of these two stations a twin Laplace point. The latitude, longitude and azimuth were determined simultaneously, applying Black's method, and using a Wild T4 universal theodolite. A publication on the results obtained is presently being printed.

3.1.2 *Twin Laplace point Zierikzee–Goedereede*

In 1969, the azimuth Goedereede–Zierikzee was astronomically determined and this completed the observations at this twin Laplace point. The azimuth Zierikzee–Goedereede and the latitude of Zierikzee were already determined in 1897, while longitude observations at both stations were carried out in the years 1949 and 1950. A report on the final results is under preparation.

3.1.3 *Laplace points Axel and Rijswijk 3*

In 1970, Laplace point observations were performed at the stations Axel and Rijswijk 3 (near satellite station Delft), applying Black's method and using a Kern DKM 3A theodolite. These measurements were carried out in behalf of the high precision traverse linking the West-European satellite stations (see section 1.2.2). The results are being studied.

3.1.4 *Publications*

Husti, G. J. – The Twin Laplace Point Ubachsberg–Tongeren, Applying the Black Method. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 4, No. 1, Delft, 1971.

3.2 **Satellite Geodesy**

3.2.1 *General*

The camera-station of the Geodetic Institute of the Delft University of Technology continued

to take part in internationally co-ordinated geodetic satellite observation programmes. The station contributed observations to the Western European Satellite Triangulation Programme, the U.S. National Geodetic Satellites Programme and recently also to the International Satellite Geodesy Experiment (ISAGEX). Both optically passive and optically active satellites were observed.

In 1969, the station was re-located, remaining, however, in the neighbourhood of Delft. It will definitively be re-established, probably in 1972, at a more suitable site near Apeldoorn.

A geodetic satellite-camera of special design was constructed on the basis of a so-called K-50 lens-cone assembly ($f = 36$ inches; f/4). This camera is equipped with an automatic re-loading device, capable of holding 8 photographic plates of size 8×10 inches. Time is obtained by means of a revolving focal-plane chopper and recorded on punched tape. It is planned to have this equipment available by mid-1971.

Rather definite plans have been worked out to supplement the camera-station with a laser range-facility of high precision. A special study has been made of technical possibilities of laser hazard-prevention in a densily populated area.

Theoretical studies have been made in several fields of satellite geodesy.

3.2.2 *Publications*

AARDOOM, L. – Geometry from simultaneous satellite ranging. Tellus, Stockholm, 1970, pp. 572–580 – 9 p.

BRUINS, G. J. – Nieuwe ontwikkelingen in de vormbepaling van de aarde. Tijdschrift voor Kadaster en Landmeetkunde, 's-Gravenhage, No. 6, 1970, pp. 238–243 – In Dutch, 6 p.

AARDOOM, L. – Dynamische en geometrische aspecten van de satellietgeodesie. Tijdschrift voor Kadaster en Landmeetkunde, 's-Gravenhage, No. 6, 1970, pp. 243–251 – In Dutch, 9 p.

POELSTRA, T. J. – Technische aspecten van het meten naar satellieten. Tijdschrift voor Kadaster en Landmeetkunde, 's-Gravenhage, No. 6, 1970, pp. 251–265 – In Dutch, 15 p., 3 fig.

4 GRAVIMETRY

4.1 **Surinam**

In 1966, a gravity survey was carried out in the western part of the continental shelf of Surinam (see Geodetic Work in The Netherlands, 1963–1966, p. 9). In 1969, this survey was continued in the eastern part of the continental shelf. The measurements were made on board of the hydrographic survey vessels H.Nl. M.S. "Snellius" (1966) and "Luymes" (1969) with the Askania sea gravimeter Gss 2 – No. 19 of the Geodetic Institute of the Delft University of Technology. Free air anomalies were computed which are in good agreement with those obtained on the adjacent land area. A map of the western part was published in [1] while a map of free air anomalies of the whole area of the continental shelf of Surinam will be included in Special Publication No. 6 of the Hydrographic Newsletter, Netherlands Hydrographic Office, The Hague. The results of the gravity observations on land were published in [2].

4.2 **NAVADO III - project**

In 1964–1965, gravity observations were carried out on the Atlantic Ocean along the parallels 22°, 25°, 28°, 31°, 34°, 37°, 40°, 43°, 46° and 49° North. These measurements formed part of the Oceanographic expedition "NAVADO" in the North Atlantic. A map of free air anomalies was published in [3] and in Geodetic Work in The Netherlands, 1963–1966 (fig. 4.1). In 1968, Bouguer- and isostatic anomalies ($T = 20$ and $T = 30$) were computed by the Department of Geodetic Science of the Ohio State University at Columbus (U.S.A.). The results of these computations are shown in the map at the end of this report.

4.3 **Netherlands Leeward Islands**

In 1962, a gravimetric survey was carried out on the Netherlands Leeward Islands Aruba, Bonaire and Curaçao. In 1964–1965, this survey was extended to the sea surrounding these islands. The results of these surveys were published in [5].

4.4 **Atlantic Ocean**

In 1969 and 1970, two new crossings were made along the parallels 7° and 4° North.

4.5 **Publications**

[1] STRANG VAN HEES, G. L. – Gravity Measurements on the Continental Shelf of Surinam. In: Scientific Investigation on the Shelf of Surinam H.Nl. M.S. Snellius. Netherlands Hydrographic Office, Hydrographic Newsletter, Special Publication, No. 5, pp. 11–14, The Hague, 1967 – 4 p., 1 fig.

[2] BOECKEL, J. VAN – Regional Gravity Survey of Northern Surinam. In: J. Veldkamp (ed.) – Gravity Surveys in Surinam and The Netherlands Leeward Islands Area, 1958–1965, pp. 7–52, Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 3, No. 3, Delft, 1969 – 46 p., 20 fig.

[3] STRANG VAN HEES, G. L. – Gravity Measurements on the Atlantic; NAVADO III. Paper presented at the 14th General Assembly of the International Association of Geodesy, Lucerne, 1967 – 7 p. , 1 fig.

[4] STRANG VAN HEES, G. L. – Gravity and Cross-coupling on the Halifax Test Range in August 1965. Paper presented at the 14th General Assembly of the International Association of Geodesy, Lucerne, 1967 – 5 p.

[5] LAGAAY, R. A. – Gravity Anomalies in The Netherlands Leeward Islands Area – A Summary. In: J. Veldkamp (ed). Gravity Surveys in Surinam and The Netherlands Leeward Islands Area, 1958–1965, pp. 57–77. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Vol. 3, No. 3, Delft, 1969– 21 p., 4 fig.

5 DYNAMIC GEODESY

5.1 **Deviations of the vertical**

In the report period no new determinations of the vertical were made in The Netherlands.

5.2 **Publications**

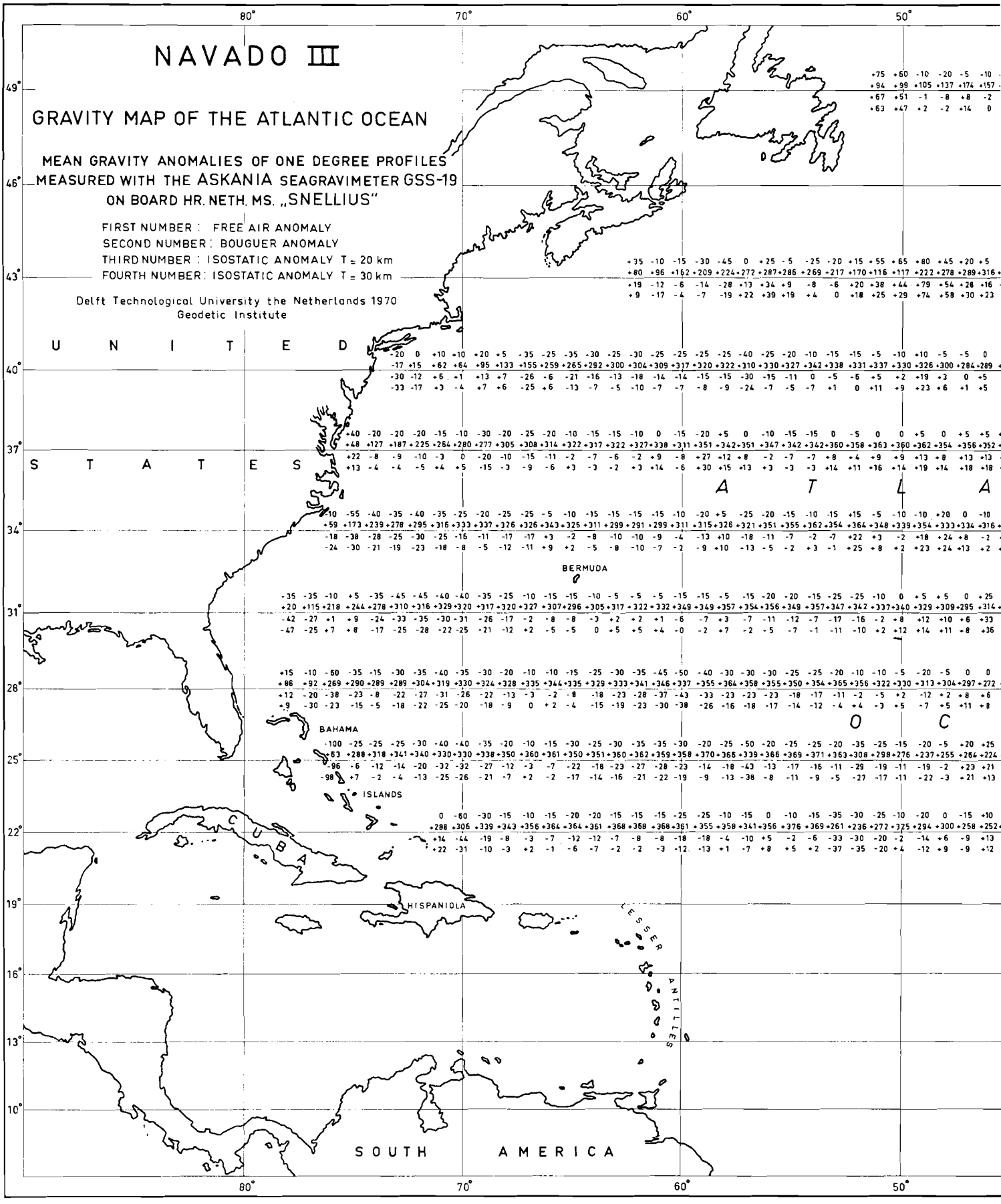
BRUINS, G. J. – A New Parameter for Ellipsoidal Calculus. Paper presented at the International Symposium Figure of the Earth and Refraction, Vienna, 1967. Österreichische Zeitschrift für Vermessungswesen, Sonderheft 25, pp. 66–68, Vienna, 1967 – 3 p., 1 fig.

BRUINS, G. J. – Some Remarks about Ellipsoidal Coordinate Systems. Paper presented at the International Symposium Figure of the Earth and Refraction, Vienna, 1967. Österreichische Zeitschrift für Vermessungswesen, Sonderheft 25, pp. 68–72, Vienna, 1967 – 4 p., 1 fig.

BRUINS, G. J. – Complex and Conjugate Harmonic Functions and Their Invariants in Geodesy. Paper presented at the 14th General Assembly of the International Union of Geodesy, Lucerne, 1967. Bulletin Géodésique No. 91, Paris, 1969, pp. 23–40 – 18 p., 3 fig.

BRUINS, G. J. – A short remark on mass- and charge distribution. Paper presented at the 4th Symposium on Mathematical Geodesy, Trieste, 1969 – 2 p.

AARDOOM, L. – Some transformation properties for the coefficients in a spherical harmonic expansion of the earths' external gravitational potential. Tellus, Stockholm, 1969, No. 4, pp. 572–584 – 13 p., 2 fig.


NAVADO III
GRAVITY MAP OF THE ATLANTIC OCEAN
MEAN GRAVITY ANOMALIES OF ONE DEGREE PROFILES
MEASURED WITH THE ASKANIA SEAGRAVIMETER GSS-19
ON BOARD HR. NETH. MS. „SNELLIUS"
FIRST NUMBER : FREE AIR ANOMALY
SECOND NUMBER : BOUGUER ANOMALY
THIRD NUMBER : ISOSTATIC ANOMALY T = 20 km
FOURTH NUMBER : ISOSTATIC ANOMALY T = 30 km
Delft Technological University the Netherlands 1970
Geodetic Institute
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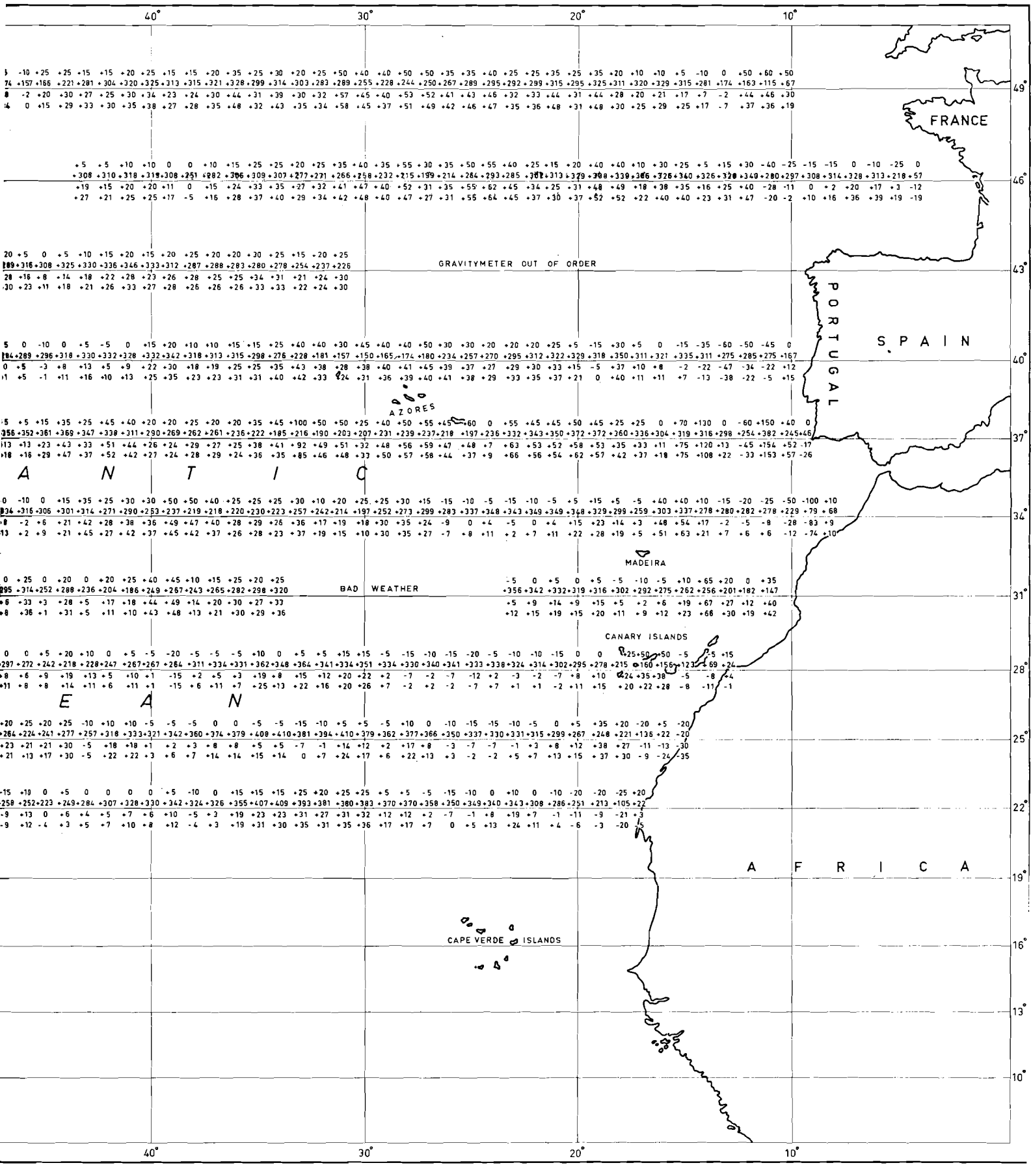
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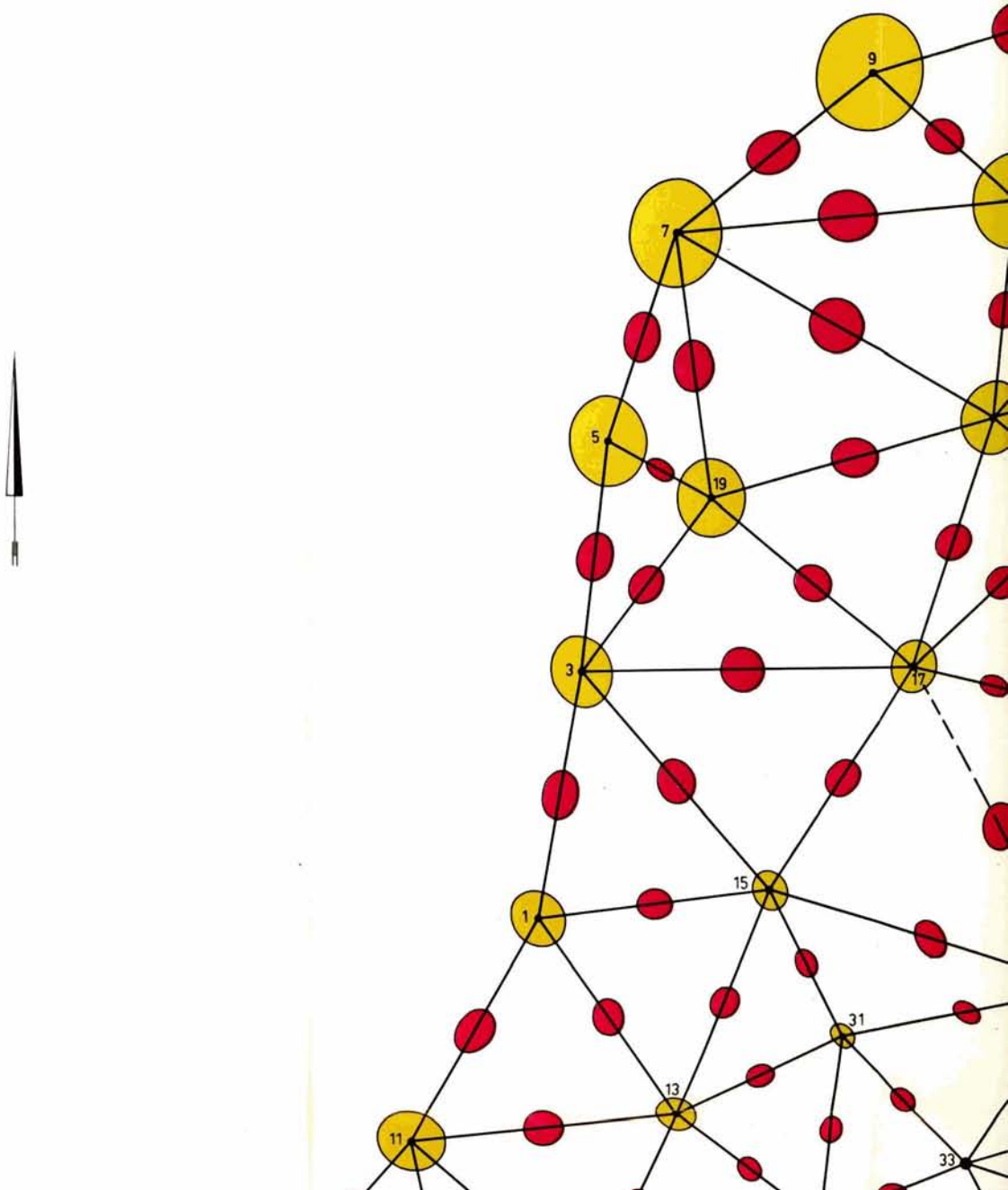

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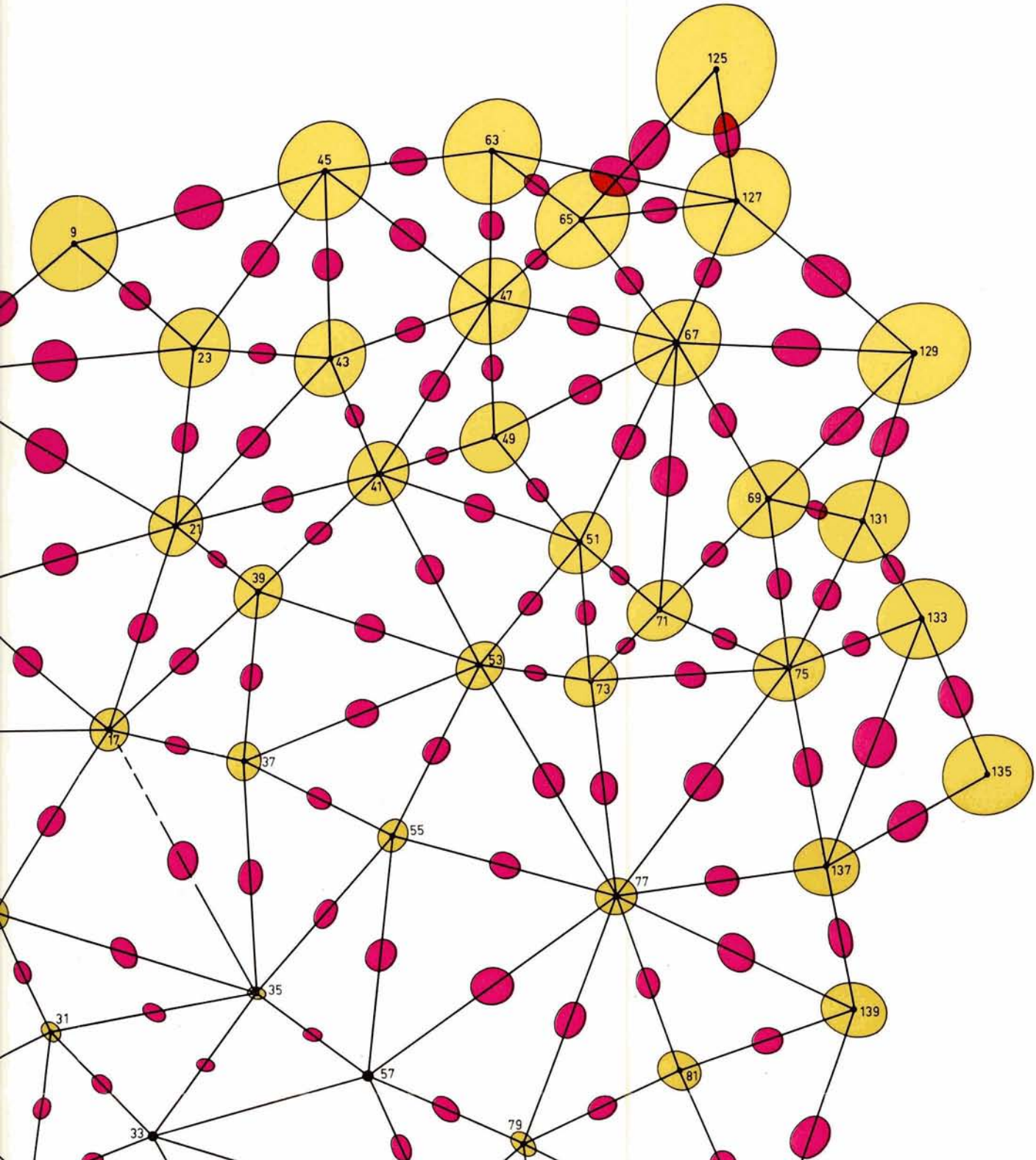

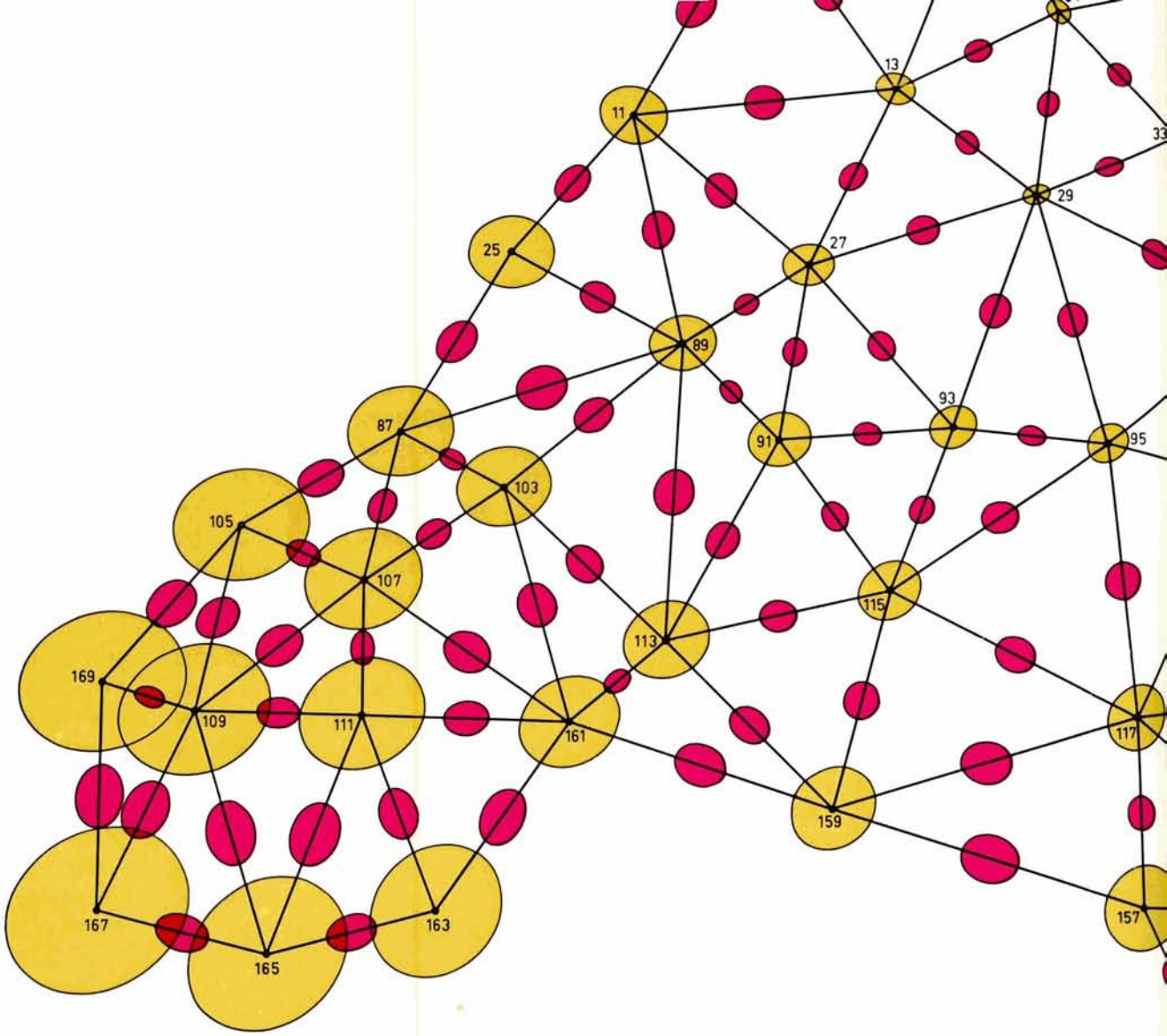

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relatieve standaardellips

} ten opzichte van de rekenbasis Amersfoort-Veluwe (33-57)

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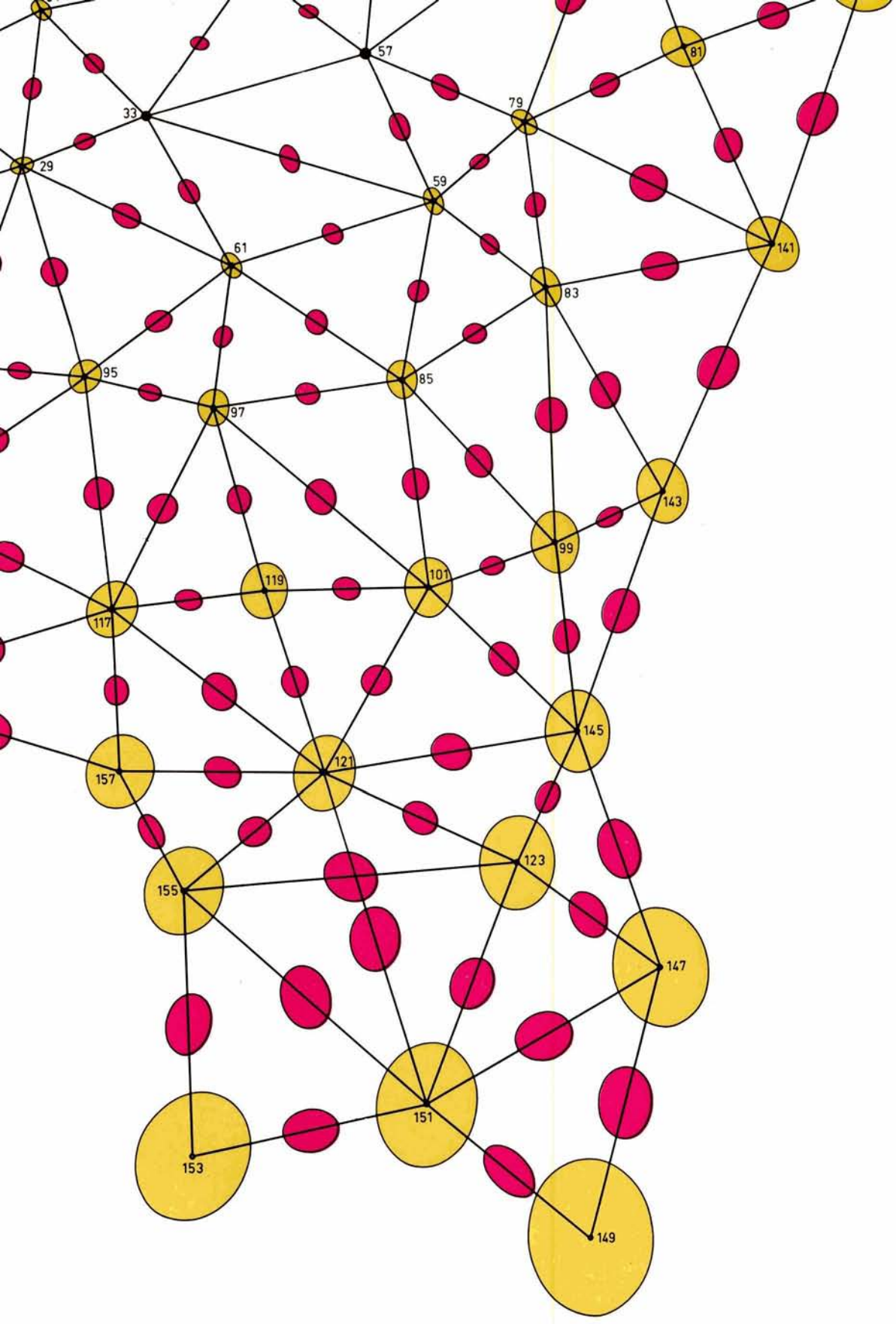
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