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The Egyptian National Gravity Standardization Network (ENGSN97)

By

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1. Introduction

An accurate gravity framework for Egypt has been established through the Egyptian National Gravity Standardization Network 1997 (ENGSN97). With a national homogeneous distribution and the utilization of precise instrumentation, the ENGSN97 serves as the accurate national gravity datum for Egypt. The project has been executed by the Survey Research Institute (SRI) starting in late of 1994 and finished in September 1998. The ENGSN97 consists of 5 absolute gravity stations and 145 relative gravity stations (Fig. 1)

2. Field Measurements

According to the project's goals, the field observation campaigns include the collection of three types of measurements: relative gravity, GPS coordinates, and precise levels. This is, of course, beside the necessary absolute gravity measurements at some selected stations.

Five absolute gravity stations have been established and observed to serve as an absolute gravity framework for the ENGSN97 network. The measurements have been done by teamwork from the U.S. National Imagery and Mapping Agency (NIMA, formally DMA) in April 1997. The locations of these sites are Giza, Helwan, Marsa Matrouh, Aswan, and El-Kharga. The measurements have been carried out using the FG5 absolute gravity meter. High-precision geodetic coordinates of each site have been obtained using GPS. Additionally, the orthometric heights of all sites have been obtained through

precise levelling. Figure 2 illustrate a description card of one of these five absolute gravity stations.

Four LaCoste and Romberge (LCR) gravimeters have been used mainly in measuring the relative gravity values of the ENGSN97:

- * Two model G gravimeters (G938 and G940).

- * Two model D gravimeters (D161 and D170).

The connections of the relative gravity loops to the absolute gravity stations have been carried out using seven LCR relative gravity meters. All loops started from the nearest absolute gravity station.

The satellite-based Global Positioning System (GPS) is the most recent and precise positioning technology used in a variety of civilian and military applications worldwide. A number of GPS receivers have been used to obtain accurate coordinates of the ENGSN97 stations. Since the station separations of the ENGSN97 network are in the average of 67 km, dual-frequency geodetic GPS receivers are used in each gravity loop. During each gravity loop, three or four GPS receivers are utilized in a base line or a network mode to get relative base lines components. Usually, a station from the Egyptian zero-order GPS network is observed during each loop so that the ENGSN97 stations coordinates are referenced to both WGS84 and the national coordinates reference datum. Moreover, in each gravity loop in the ENGSN97 project, the orthometric height of each station is determined by precise levelling.

3. ENGSN97 Results

Several gravity-processing models have been developed in the form of observation equations, for a gravimeter reading, as a function of the involved unknown parameters. Those developed processing models have been utilized and several efficient computer programs have been developed to process, adjust, and analyze gravity networks. The Gravity Network Processing and Adjustment (GNPA) software, developed by one of the SRI researchers, was the main computational tool used in this project. It processes and adjusts a gravity network that consists of several field loops observed by several gravimeters, with or without time breaks in the observation scheme. As an indication of the precision of the ENGSN97 network, the standard deviations of the adjusted gravity values range from ± 0.002 mGal to ± 0.048 mGal, with an average value of ± 0.021 mGal. Based on the ENGSN97 results, the free-air and Bouguer gravity anomaly maps for Egypt have been updated based on utilizing all the available gravity data.

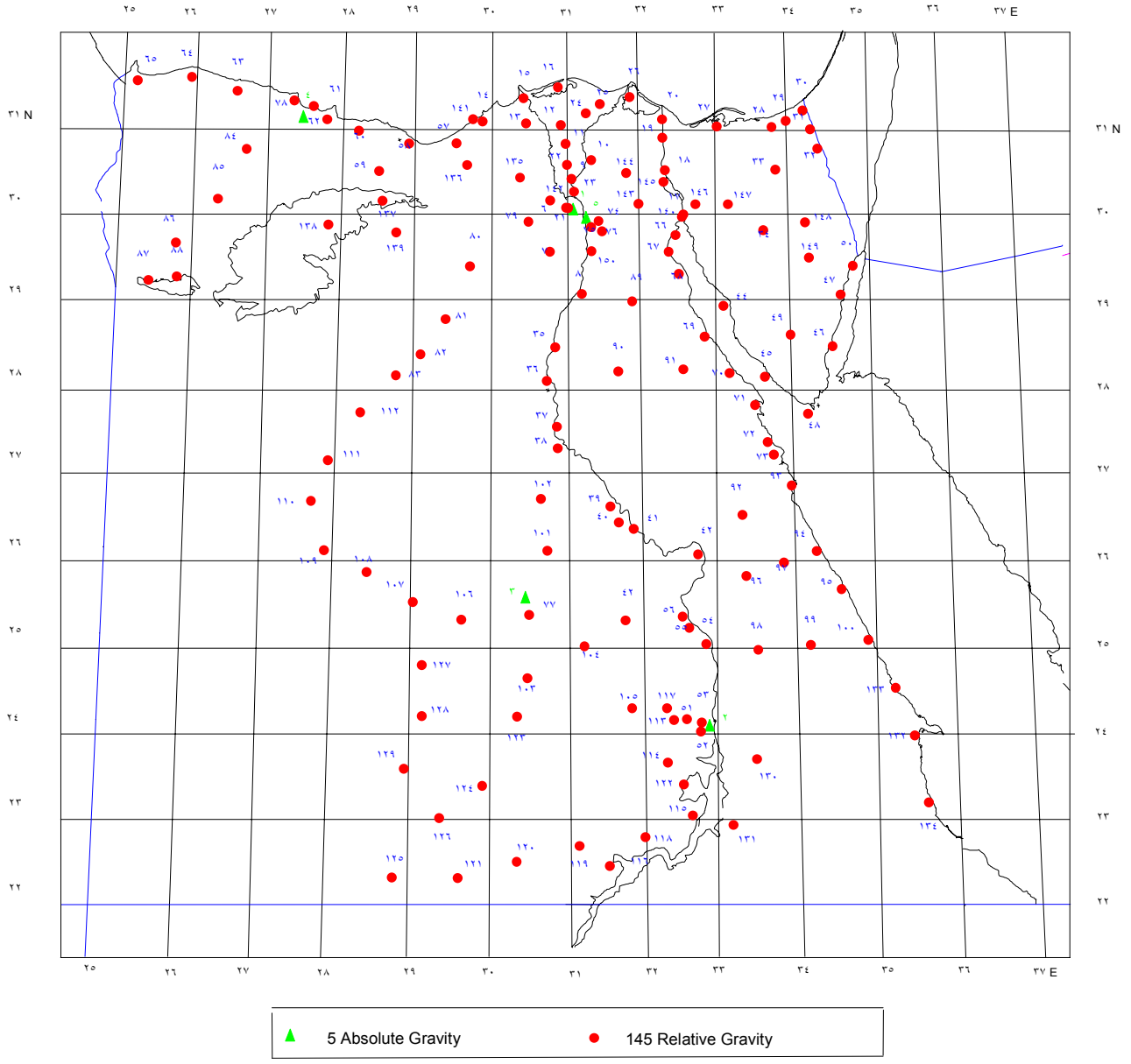


Fig. 1
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The Egyptian National Gravity Standardization Network

Station No. : SRI 1 Location: Giza City
Un-adjusted Gravity Value = 979300 mGal
Coordinates: Latitude= 30 00 10 N, Longitude= 31 10 50 E, Height= 19 m above MSL

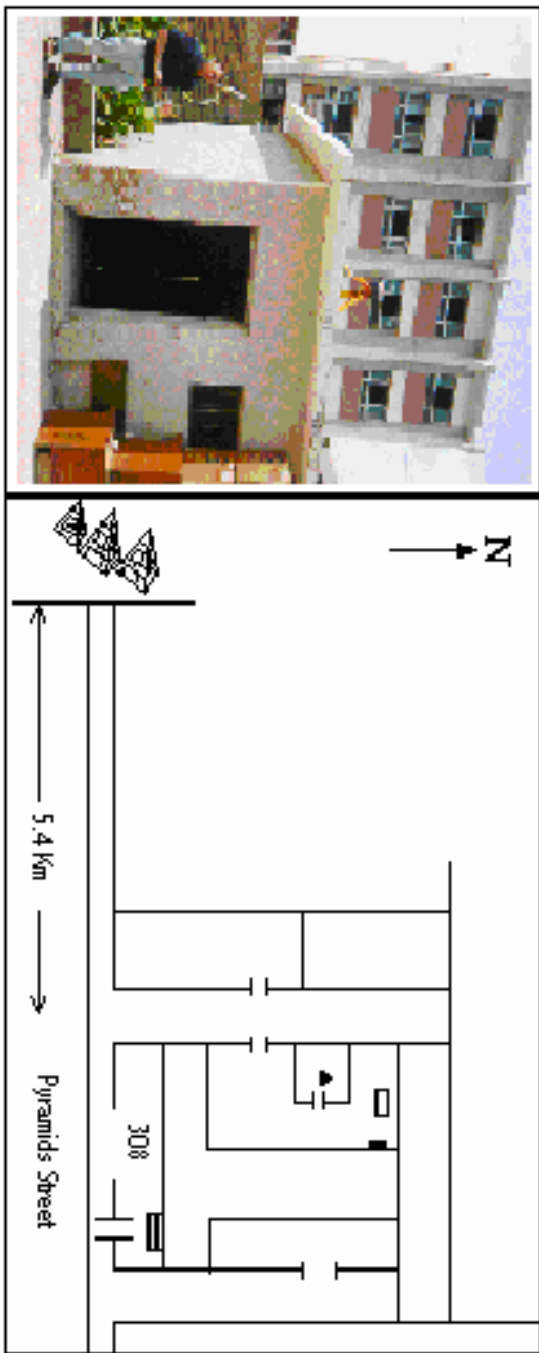


Fig. 2
An ENGSN97 Absolute Gravity Station