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GEOMAGNETIC SURVEYS ON THE TERRITORY OF SOFIA AIRPORT

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Abstract

Geomagnetic surveys on the territory of Sofia Airport for measuring of geomagnetic declination and to obtain the suitability of the sit for compass calibration pad are described in the paper.

Considered is the applicability of the world geomagnetic field models, as example IGRF, when geomagnetic data with high accuracy are needed.

Introduction

There are tow primary objectives in performing airport geomagnetic surveys. The first is to determine geomagnetic declination at suitable sit and second to obtain the suitability of the sit for compass calibration pad. Geomagnetic declination is determined using procedures developed by International Association for Geomagnetism and Aeronomy (IAGA) [1]. The suitability of the sit for compass calibration pad is assessed using the standards outlined in Federal Aviation Administration (FAA) of the United States. In Bulgaria Geomagnetic Service at National Institute for Geophysics, Geodesy and Geography provide airport geomagnetic surveys for many years.

Because of the increased requirements for flight safety in Bulgaria last years teams from the National Institute for Geophysics, Geodesy and Geography performed measurements of the geomagnetic declination at many airports, including Sofia Airport [2]. Also in 2008 were carried out

surveys at the Sofia Airport to obtain the suitability of the sit for compass calibration pad.

Measurement of geomagnetic declination on Sofia Airport

Geomagnetic declination on the Sofia airport was first measured at the threshold of the runways (this is the point for take off and landing of the airplanes). Large anomalies were detected at the runway thresholds. For example, the difference between the measured declination on the eastern and on the western part of Sofia airport was $4^0 25'$. Our opinion is that the large difference is due to the concrete with substantial steel reinforcement of the runway. Knowing that the airplanes use the geomagnetic declination in the air far of the runway we decided to make the measurements away from the runway. At the Sofia Airport the measurements were made at the nearest repeat station of the Bulgarian geomagnetic repeat stations network. In this point the value in 2001 was $3^0 10'$. This value is reduced in epoch 2010.5 by using the data for geomagnetic declination changes from geomagnetic observatory Panagyurishte (Bulgaria) and the value is $3^0 53'$.

Obtain the suitability of the sit for calibration pad on Sofia Airport

FAA requirements for design, location and construction of a compass calibration pad are detailed in FAA AC (advisory circular) 150/5300-13 Appendix 4. The advisory circular may be obtained at the internet site [3].The criteria of a site location suitability in accordance with the AC are:

-The difference between geomagnetic and geography north must be uniform across the site.

- The range of declination must be less than one half degree (from 0,3 to 3 meters above the base and 75 meters off the center).

Section 5 of the FAA Advisory Circular provides guidelines for locating a suitable site for calibration pad. The general requirements for location are:

- Locate a calibration pad 90 meters from power and communication cables and other aircraft.
- Locate a calibration pad at last 180 meters from large magnetic objects, such as buildings, railroad track, high voltage transmission lines, or cables with direct current.

- Locate calibration pad off the site of a taxiway or runway to satisfy local clearances.

In the late spring of 2008 were carried out preliminary site checks on the territory of Sofia airport and as a result two sites were proposed for calibration of the compasses of airplanes types Airbus 320 and Boeing 737. The first one (Site 1) is situated at the end of taxiway K and N on the airport and the second one (Site 2) is the western ground for anti-icing system (Fig.1).

Fig. 1. Site 1 and Site 2 on the Sofia Airport map

On these two sites and then a magnetic total field survey was carried out. A geomagnetic total field survey of an existing new calibration pad is essential to determine the suitability of the site because preliminary checks may not show buried ferrous metals which can impact the magnetic field. The equipment used for survey was proton magnetometer PMP 5A. Procedure for total field survey is:

- Mark the center point with wooden stake.
- Make total field readings (mean value of 5 readings) at the center point and approximately every 5 meters along N-S and E-W lines out to 35 meters.

If the total field has a range of 75 nT over a 75 meter area, it will meet the FAA requirements. Total field survey results are used to rank potential compass calibration pad sites. Following the total field survey, a single site must be chosen for construction of the calibration pad after which a detailed geomagnetic declination survey must be made to confirm the site meet the FAA requirements.

The results from the total field geomagnetic surveys on the territory of Sofia airport are presented further down.

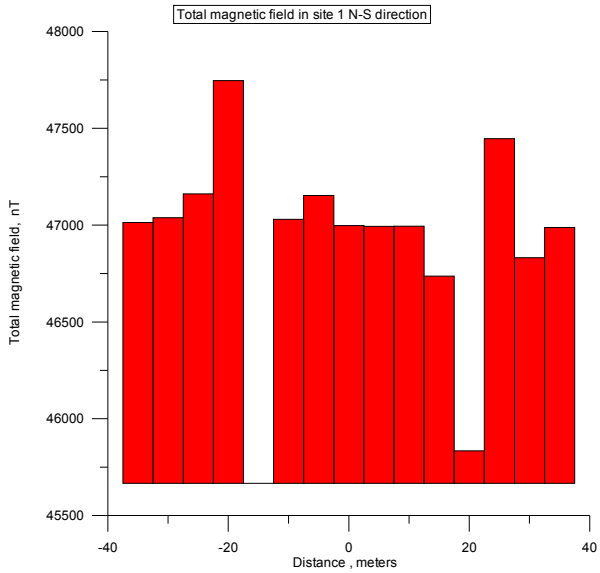

Fig. 2. Total magnetic filed (nT) in site1 N-S direction

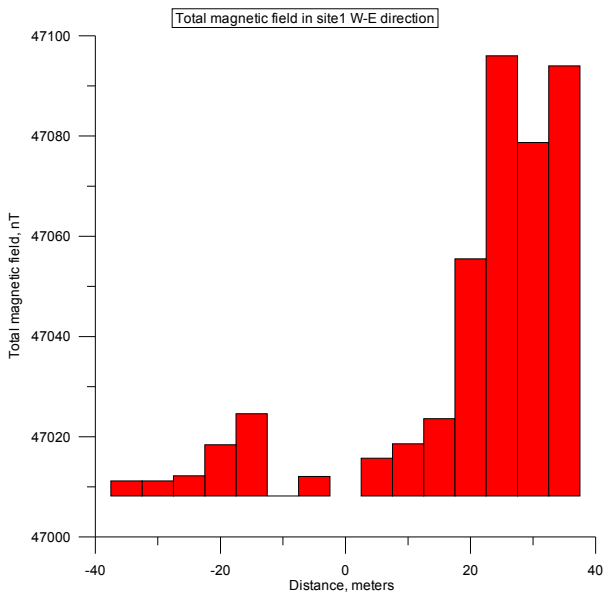

Fig. 3. Total magnetic filed (nT) in site1 W-E direction

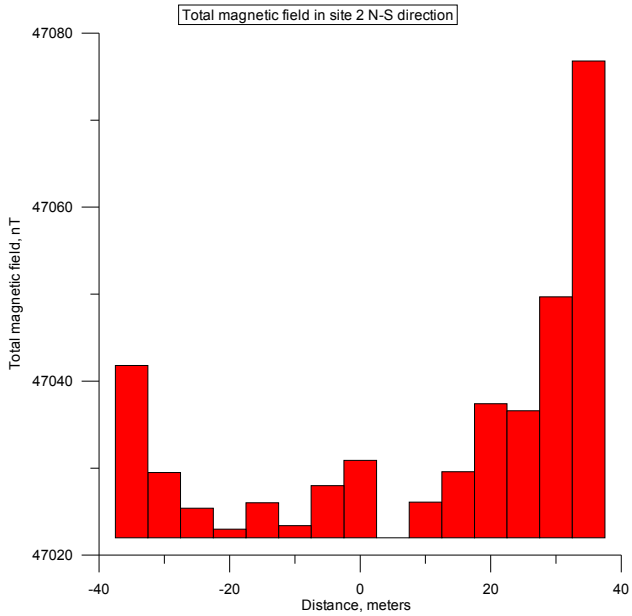

Fig. 4. Total magnetic filed (nT) in site2 N-S direction

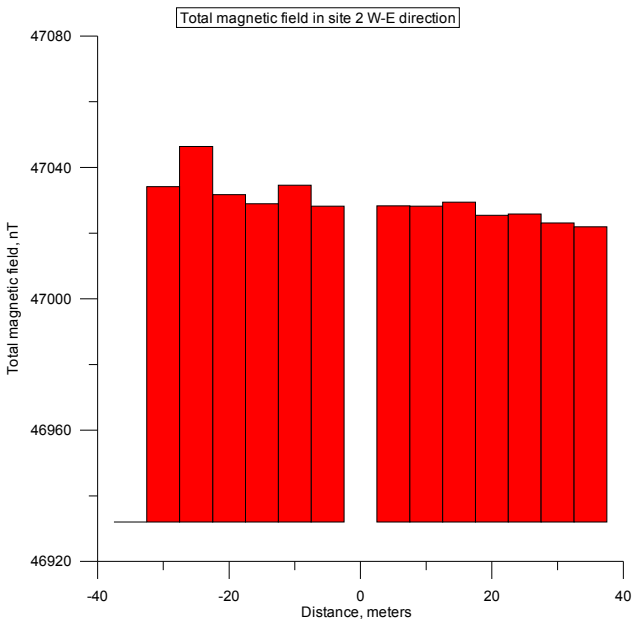

Fig. 5. Total magnetic filed (nT) in site 2 W-E direction

On the Fig. 2 and Fig. 3 are sown the values of the total geomagnetic field measured along N-S and E-W lines for Site 1. As it is clearly visible this site do not meet the FAA requirements because the range of magnetic field changes in N-S direction is more than 2000 nT and in W-E direction is approximately 90 nT.

On the Fig. 4 and Fig. 5 are sown the values of the total geomagnetic field measured along N-S and E-W lines for Site 2. The range of magnetic field changes in N-S direction is approximately 55 nT and in E-W (for 14 measurement points) is less than 30 nT and only in one measurement point is less than 120 nT. Probably this anomalous value has accumulated big measurement error caused by small local ferrous disturber and can be ignored. We can see that Site 2 meet the FAA requirements. The mean value of total magnetic field in Site 2 is 46969,4 nT and the field gradient is lese than of 1 nT/meter in the all area with dimension 75x75 meters .

As a conclusion is established that Site 2 is a suitable sit for building of new compass calibration pad on Sofia Airport.

About using of the world models for obtaining of geomagnetic field component values

A frequently asked question is: Is it possible to use geomagnetic field data, calculated from a world model, for example the International Geomagnetic Reference Field (IGRF) [4], in airport practice? As we know this is a global model of the geomagnetic field. It allows spot values of the geomagnetic field vector to be calculated anywhere on the Earth's core out into space. But for obtaining of the geomagnetic vector component values in a concrete point the model is not very accurate. We will demonstrate this further down. In epoch 2000.5 the model (IGRF-11/2010) for the spot of Geomagnetic Observatory PAG gives for geomagnetic declination a value $3^0 21{,}36'$ and for epoch 2005.5 - $3^0 42{,}24'$, but the measured thru values are $3^0 00{,}5'$ (2000.5) and $3^0 22{,}6'$ (2005.5). The absolute error is more than $0^0{,}21'$ in both cases. Similar are the results and for the total field, in epoch 2000.5 the model (IGRF-11/2010) for the spot of Geomagnetic Observatory PAG gives value 47011 nT and for epoch 2005.5 - 47166 nT. Thus we see that the model IGRF is not applicable when high accuracy is needed. It became clear that this is very important especially for obtaining of geomagnetic declination by the model anywhere on the Earth's core.

We will introduce here an alternative way for obtaining of the geomagnetic field elements values at Sofia Airport in the next ages after the epoch of measurements. For example for the element geomagnetic declination we obtained in epoch 2001.5 the measured declination value at the airport is $3^0 10'$ and in Geomagnetic Observatory PAG is $3^0 04'$. The value difference between these tow space points is $0^0 06'$.This difference is stable in relatively long time interval and thus we can obtain the value at the Sofia Airport in some next epoch by reduction of the observatory value for this same epoch by mentioned above $0^0 06'$. For example in 2007.5 observatory declination value is $3^0 32,4'$ and at the Sofia Airport reduced value therefore is $3^0 38,4'$. This method is applicable with small error for periods close to 10 years after the epoch of measurements, but for obtaining of values for longer time interval repeat measurements at the territory of airport are necessary.

References

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ГЕОМАГНИТНИ ПРОУЧВАНИЯ НА ТЕРИТОРИЯТА НА ЛЕТИЩЕ СОФИЯ

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Резюме

В работата са описани геомагнитни проучвания на територията на летище София за определяне на геомагнитната деклинация в различни епохи и за намиране на подходяща площадка за калибриране компасите на самолети от типове Airbus 320 и Boeing 737. Разгледана е и приложимостта на световните геомагнитни модели, като например IGRF, в случаи на необходимост от геомагнитни данни с висока точност.