SCIENTIFIC NOTE

THE POSSIBILITY OF STANDARDIZING THE AIRBORNE GAMMA RAY DATABASE OF GEOSURV

Key words: Airborn, Gamma ray, Iraq

INTRODUCTION

The first airborne gamma ray survey of Iraq accomplished 40 years ago by Compagnie General De Geophysique (CGG). The results are several count-rate maps of different scales of Potassium, Uranium, Thorium and Total Count. The survey parameters were a spectrometer designed by Exploranium Company (DGRS 3000) detecting gamma rays by 800 cubic inches NaI sodium iodide scintillation crystal associated with photomultipliers with digital recording. The flight line spacing was 2 Km and in some places 5 Km, and the whole area was flown at an altitude of (135 – 140 m) except for some blocks over the alluvium plain where it was flown at a constant barometric altitude of 400 m (Fig.1). Band widths of the radioelement and the sensitivities are shown in Table (1). The corrections made on the raw data are Compton Scattering Correction and altitude correction, (CGG, 1974).

According to the International Atomic Energy Agency (IAEA, 2003), (Grasty *et al*., 1997) and (Minty *et al*., 1997), these parameters may not meet the recent standards due to the development of later standards and calibration procedures. Furthermore, the IAEA have shown that the early measurements were often taken with uncalibrated equipment and the data were reported in units that are relative measure of the radioactivity while recent gamma ray spectrometer survey results are reported as either dose rate or radioelement concentrations, which is not the case with the data of the Iraq Geological Survey (GEOSURV). Therefore these data need detailed assaying and quality checking. The IAEA has played a major role in upgrading airborne gamma ray data by sponsoring standardization and back-calibration missions in many countries. The general procedure is quality checking of the original radiometric data to ensure that the data are leveled. The data are then converted to dose rate in air or radioelement abundance in rocks (IAEA, 2003). This note tries to show the fact that the airborne database need to be upgraded and shows how gamma ray data in countries like Australia and the Czech Republic were standardized and the possibility of applying such program to upgrade the airborne gamma ray database of GEOSURV, through the IAEA sponsored program.

Table1: Band widths and sensitivities used by CGG airborne survey

Window name	Band width (MeV)	Sensitivities (CPS)
Total count	0.24 – 3	2000
Potassium	1.35 – 1.57	50 0R 100
Uranium	1.63 – 1.89	50 0R 100
Thorium	2.42 – 2.82	50 0R 100

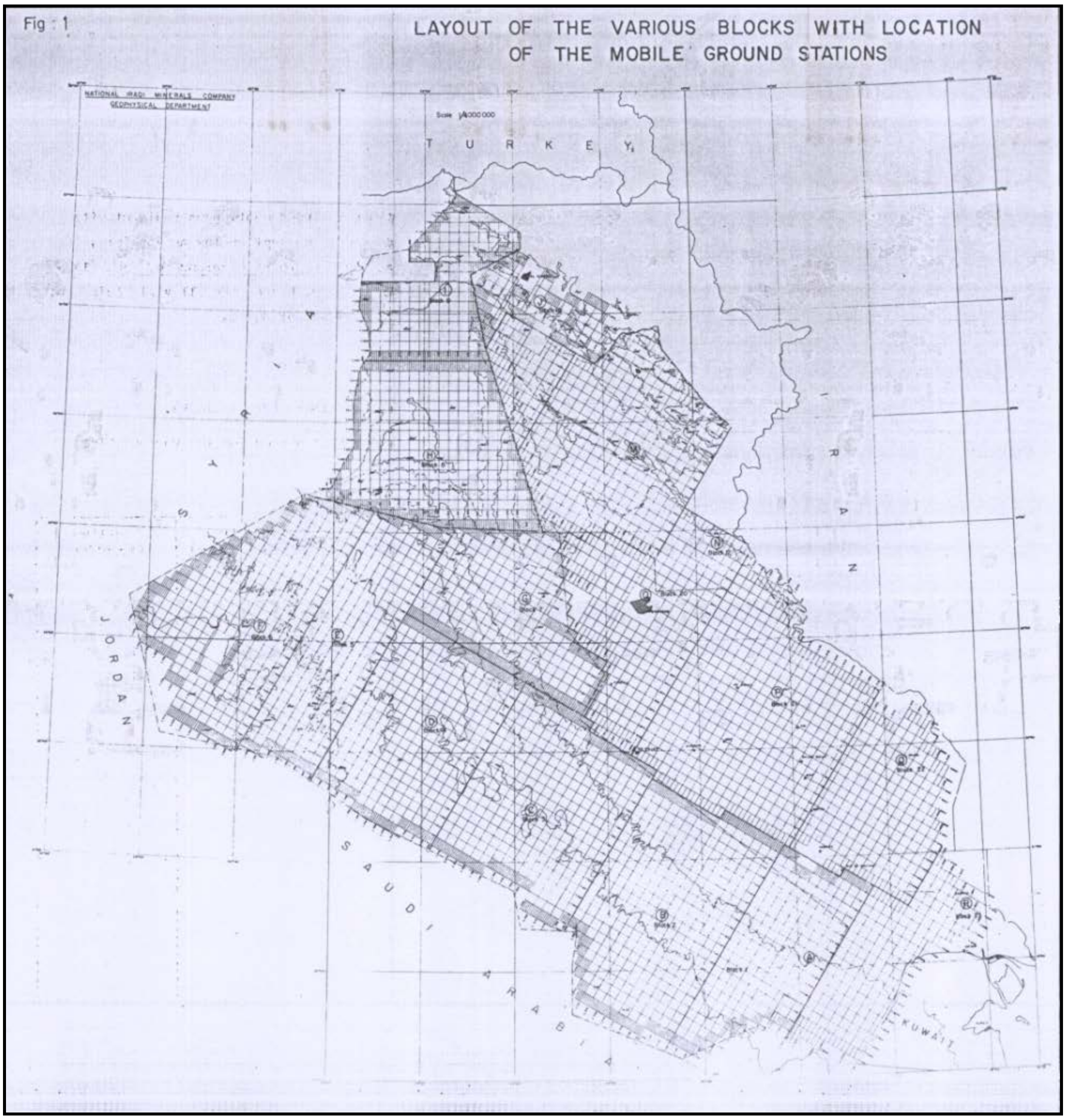

Fig.1: CGG airborne survey coverage of Iraq

Recent gamma ray spectrometric survey results are reported as either dose rate or radioelement concentrations. Standardization is the procedure for converting total counts measurements to dose rate or radioelement concentration. This procedure starts with assaying the quality of the gamma ray airborne data by checking the calibration procedures used, the corrections applied on the raw data and sensitivity factors and then customizing back-calibration program which can be described as the comparison of the mapped count rates with radioelement concentrations measured with calibrated portable gamma ray spectrometer.

The portable spectrometers are more accurate because the background component is lower on the ground than on the airborne systems and the counting time can be increased to obtain more precise estimate of the radioelement, and as such it is time consuming and costly. The approach taken to the selection of back – calibration sites depends on the radioactivity variability with uniform concentrations of the radioelement, topographically flat as well as being easily accessible (IAEA, 2010).

Grasty *et al*. (1997) have described three procedures to compare ground measurements with airborne data: **1)** along one flight line **2)** over several large uniformly radioactive areas **3)** at the intersection of roads with flight lines. The conversion factors are estimated using linear regression of the mean ground concentrations of K, U and Th against the mapped count rates (Fig.2) (IAEA, 1996). Back-calibration method has been used worldwide to upgrade old airborne data.

Australia have upgraded airborne database to conform with the IAEA global radioelement datum by taking ground measurement, at the intersection of roads with flight lines. Forty seven field sites were selected in areas with subdued topography and easily accessed along the road network. Four (300) s measurements were taken using calibrated portable gamma ray spectrometer; two measurements at each side of the road, spaced 20 m apart. The ground concentration estimates were computed at each calibration site and compared with the mean concentration estimate of the airborne data within a radius of 800 m of the calibration site and the correction factors for each site were estimated. The final Australia – wide Airborne Geophysical Survey (AWAGS) correction factors for K, U and Th were calculated as the weighted average of all the site correction factors with each site weighted inversely by their error variances (Fig.3a and b). A grid leveling method described by Minty (2000) has been used to adjust the radioelement database of Australia to a common datum. Correction factors have been estimated for each survey in the database that, once applied minimizes both the differences in radioelement estimates between surveys (where these surveys overlap) and the differences between the surveys and the AWAGS traverses (where these surveys overlap). This effectively levels the surveys to the IAEA datum; the results are shown in (Figs.4a and b). The leveled database has been used to produce the radiometric map of Australia and ternary image of K, eU and eTh (Figs.4c and d) (Minty *et al*., 2009) (Minty, 2000 in Minty *et al*., 2009).

In the Czech Republic a calibrated portable gamma ray spectrometer was used to survey 122 regional ground traverses between 1 to 5 Km long. The traverses were chosen over low, medium and highly radioactive rocks and the results were expressed in gamma dose rate (nano gray per hour nGy/h). Regression analysis between dose rate data and the airborne data resulted in constant multiplication correction for the airborne data (Fig.5) (IAEA, 2003). Also Back-calibration program was applied in Malaysia, Portugal and Argentina sponsored by IAEA.

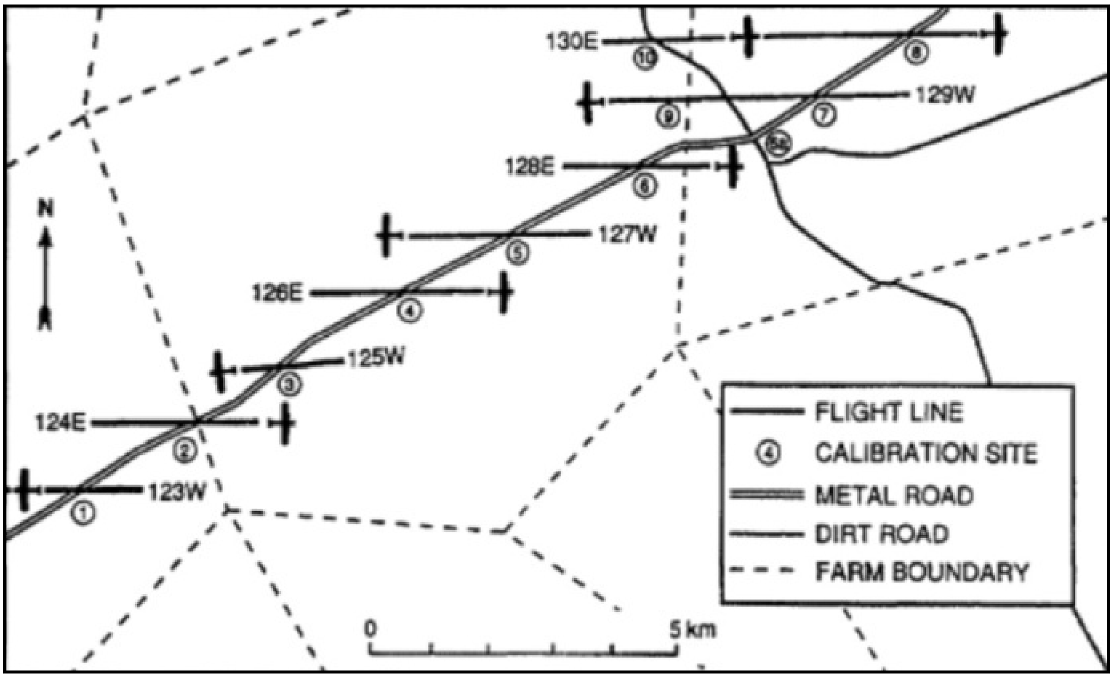

Fig.2: Ground calibration sites taken at the intersection of flight lines with roads (after IAEA. 1996)

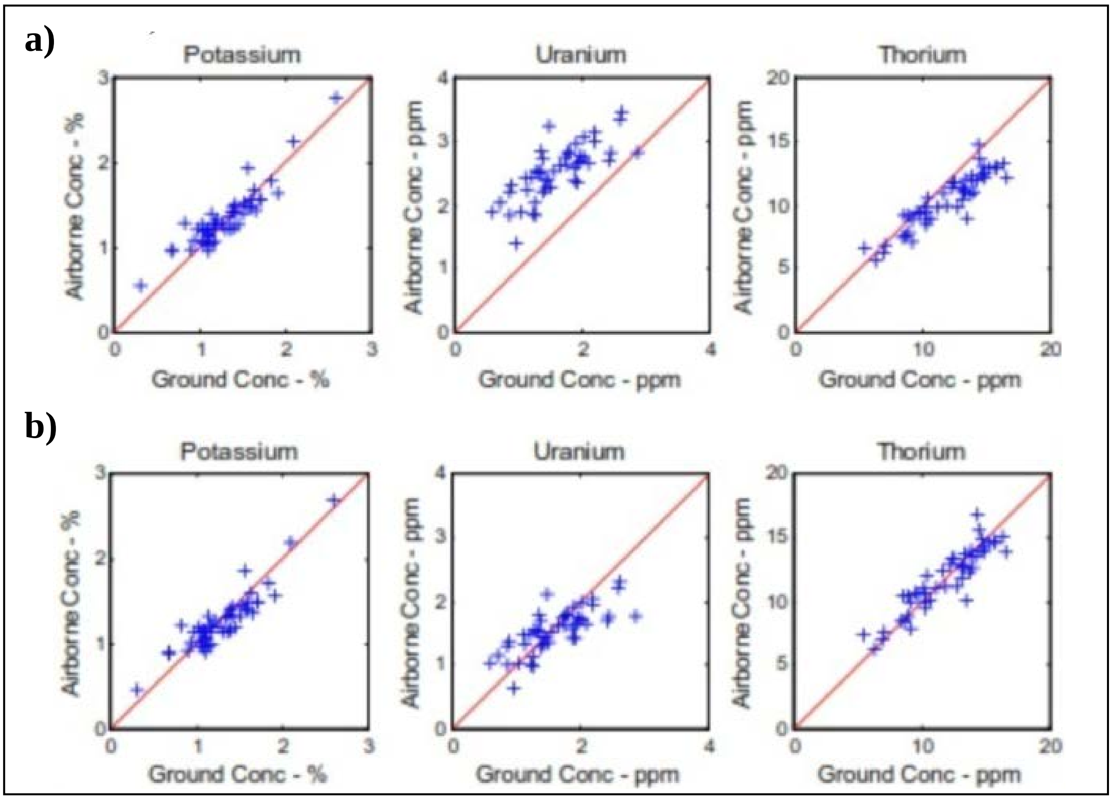

Fig.3: Correlation between airborne and ground radioelement estimates for each of K, eU,and eTh. **a)** before back-calibration, **b)** after back-calibration, (after Minty *et al.*, 2009)

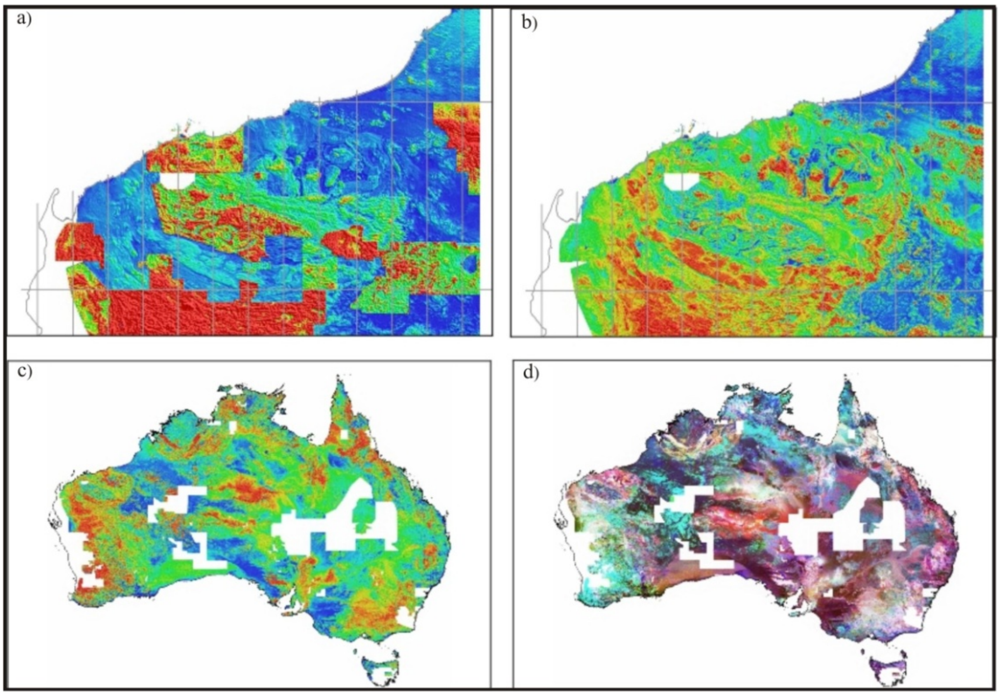

Fig.4: **a)** showing eTh data for Pilbara region, Western Australia, before grid leveling, **b)** showing eTh data for Pilbara region, Western Australia, after grid leveling, **c)** Pseudo colour image of air – absorb dose rate (nGy/h). **d)** Ternary image (K-red, eU-blue, eTh-green) of Australia derived from the new leveled radioelement database (after Minty *et al*., 2009)

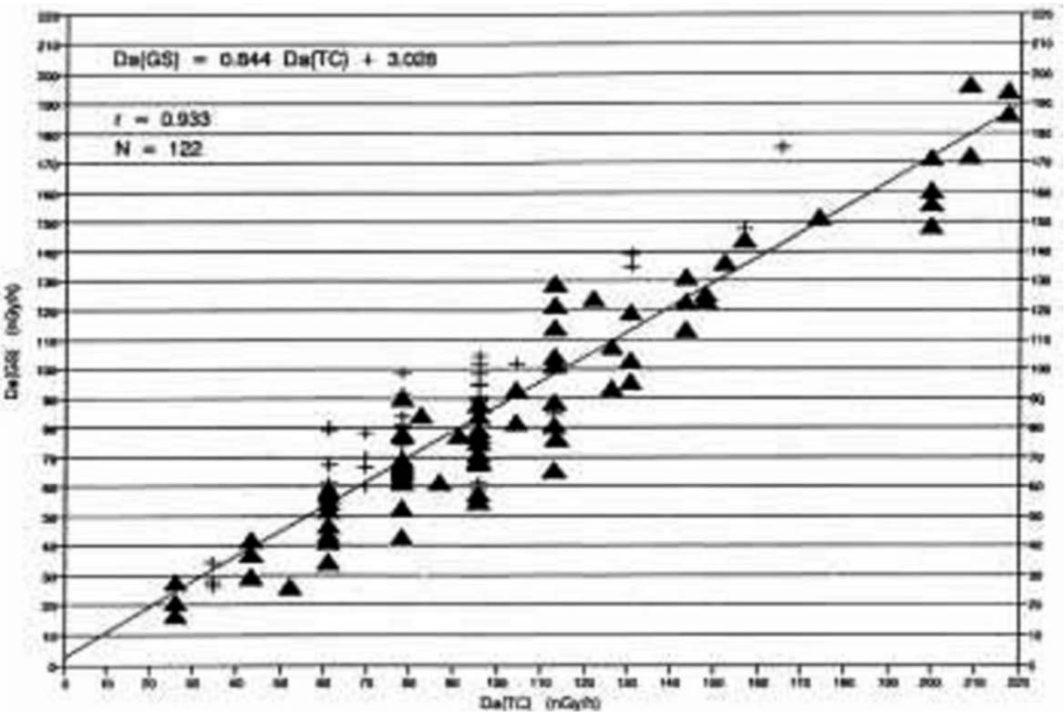

Fig.5: Regression of gamma dose rates determined by ground gamma ray spectrometry (GS) and airborne total count measurement inthe Czech Republic (TC).Δ-GS measurement on the earth surface, + GS measurements in hole 0.6 m deep (after Matolin, 1997a, in IAEA, 2003)

The IAEA has sponsored back-calibration programs throughout the world helping many countries to upgrade their database. It is important to collaborate with the IAEA to assay GEOSURV airborne gamma ray database and sponsor such program because the IAEA (IAEA, 2010) recommended that all gamma ray spectrometric surveys be referenced to the agency global radioelement datum based on reference standards issued by the IAEA's Siebersdorf Laboratory (IAEA, 1987 in Minty *et al*., 2009). Such collaboration will provide a new leveled database that will be used to reproduce the radiometric map of Iraq, ternary images, exposure rate maps and ground concentration maps of K, U and Th. The upgraded database will support many applications such as researche in land use modeling, radiation risk maps, mineral exploration, regional geology, regolith and soil mapping and direct comparison with geochemical data. All these applications can be correlated and overlaid using Geographical Information System (GIS) and Geosoft softwares. The aero-spectrometric survey was made almost 40 years ago and therefore, it is no longer accepted for uranium exploration, geological mapping and mineral exploration unless it goes through standardization and back-calibration program.

ACKNOLEDGMENETS

I would like to express my sincere thanks to Mr. Jassim A. Al-Bdaiwi, Dr. Abbas M. Yass and Mr. Hayder A. Al-Bahadily for reviewing this scientific note and presenting their valuable comments.

Ali F. Al-Dujaili, Assistant Geologist, Iraq Geological Survey, P.O. Box 986, Baghdad, Iraq,
e-mail: ali.fr.jasim1@gmail.com

REFERENCES

Compagnie Generale De Geophysique (CGG), 1974. The Aerometric Survey and Aerospectometric Survey of Iraq, Massy, France. GEOSURV, int. rep. no.2642.

Grasty, R.L., St. John Smith, B., and Minty, B.R.S., 1997. Development in the standardization and analysis of airborne gamma ray data. In "Proceedings of Exploration 97: Fourth Decennial International Conference on Mineral Exploration" http://dmec.ca/ex097dvd/decennial/expl97/08/01/pdf.

IAEA, 1996.Uranium Exploration Data and Techniques Applied to the Preparation of Radioelement Maps, IAEA-TECDOC-980, IAEA, Vienna. http://pub.iaea.org/mtcd/publication/pdd/te-980-web.

IAEA, 2003. Guidelines for radioelement mapping using gamma ray spectrometry data, IAEA-TECDOC-1363, (international atomic energy agency, veinna). http://pub.iaea.org/mtcd/publication/pdd/te-1363-web.

IAEA, 2010.Radioelement mapping, IAEA-TECDOC-1463, (international atomic energy agency, veinna). http://www-pub.iaea.org/MTCD/../PDF/PUB1463_web.pdf

Minty, B., Luyendyk, A. and Brodie., 1997. Calibration and data processing for airborne gamma-ray spectrometry. AGSO Journal of Australian geology and geophysics, 12 (2) 51 – 62. http://www.ga.gov.au/webtemp/image-cache/GA1688.

Minty, B., Franklin, R., Milligan, F., Richardson, L.M., and Wilford, J., 2009. The radiometric map of Australia paper presented at the 20th international geophysical conference and exhibition, Australian society of exploration geophysicist, Adelaide, 22 – 25, February, 2009 http://www.ga.gov.au/webtemp/image-cache/GA13928.