ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

THE GRAVITY FIELD OF THE SOUTHERN ETHIOPIAN RIFT SYSTEMS BETWEEN 3.3^0 TO 7.15^0 N LATITUDE AND 36^0 TO 42^0 E LONGITUDE

BY
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MAY 1997

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A Thesis
submitted to the
School of Graduate studies
Addis Ababa University

In partial fulfillment of
the Requirements of the Degree
Master of Science in Geophysics

May 1997

Acknowledgement

I am indepted to my supervisor Dr. Abera Alemu for his advice, encouragement and guidance throught the process of this research. I have really benefited not only from his publications and his collection but also with the data of this research which is the core of my study. He is my advisor, father, friend and overall a man of principle with positive attitude towards me.

I would like to acknowledge my Co-supervisor Ato Befekadu Oluma for providing computer facilities and critical reading of my paper following each step of my work. With out his cooperation this research could not be practical. My second acknowledgement goes to Ato Berhanu Bekele, For Head Geophysics Department (EIGS), the unfogetable friend Ato Taha Abdo, who assisted me in computer ussage, W/t and Almaze Mengiste. I apologize to those peaple of the EIGS whose names I may have inadvertently omitted, thier aid is also greatly acknowledged.

I am also grateful to Prof. Balia for his valuable comments in the interpretation of the gravity anomaly maps.

Let God bless my Mather, Brathers and Sisters with out whome I could not be successful. It is the patient of my Brather Ato Abraham Asrat that brought the end of all those hard times peacefully.

I cannot forget my friends Etsubdink Wegayehu, Eyob W/Michael, Berhe Kahsay, Amaha Haile, Tekeste G/leol, Amanuel Hadgu, Sebhatleab G/selasie, Amanuel (and his computer aid too), Yemisrach who encourage me during my studies and were looking at my success.

The unforgetable University life of group seven friends Zekarias Berhane, Goitom Zekiros, Goitom T/Michael, Hewan Tesema, Aster Asefa and Mola Mengesh, who faced with me the troubles of my undergraduate life.

Being in the School of Graduate Studies Lijam Zemichael, Line Berhane, Zekarias Berhane, Netsereab A/Haimanot, Estifanos Haile Efrem okbabe are unforgetable.

I say thanks to the staff of the Geology and Geophysics Department who helped me during my research work.

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ABSTRACT

1800 gravity data covering the research area are reduce to Bouguer and free air values and interpreted based on the Bouguer anomaly map and a pair of short wave length (SWL, residual) and long wave length (LWL, regional) anomaly maps. All data are reduced to sea level wth uniform density of 2.67 g/cm^3. Effect of Bouguer masses were calculated applying the simple Bouguer corrections. Terrain correction was not applied.

The Bouguer anomly map of the rift zone between 3.3^0 N to 7.15^0 N and 36^0 E to 42^0 E is presented. The geologic and tectonic setting of the area is discussed based on the compilation of gravity data and synthesis of published papers.

A positive Bouguer gravity anomaly of -165 mGal occur over the rift floor of the Abaya - Chamo rift and is flanked by negative anomalies that reside on its shoulders. Gravity anomaly of magnitude -135 mGal is observed over the Chew Bahir rift floor and flanked by relative positive anomalies on its shoulders, which is different from the MER. This could be due to lacustrine deposits of the rift floor.

The free - air anomaly map is simply related to topographic relief . The uplifted blocks and horsts are characterised by high free - air gravity anomaly and depressions defined by free - air minimum (-40 to -75 mGal). The transition from grabens to horsts is marked by sharp free - air gravity gradients (0 to +40 mGal).

After removal of the long wave length components of the Bouguer gravity anomaly the residual gravity anomaly is interpreted. The residual gravity field exhibits rapid changes of gravity gradients over short distance appears to show the presence of faults which bound major rift basins. Anomalous areas are corelated to their respective geologic interpretation.

The regional gravity anomaly map produced by trending analysis shows the deep structural features of the study area. It shows the transition from negative to positive gravity field from MER to SER and negative towards the Kenyan rift indicating the distinction between the SER and the other two rift systems (MER and Kenyan rifts).

CHAPTER ONE

1.INTRODUCTION

Over the years gravimetric research has been a problem to all developing nations and Ethiopia being one, has experienced these difficulties since the need for a well organized gravimetric research first arose. It was also noted that this problem and its practical solution should be one of the first questions to be dealt with in the frame work of the African Gravity Standardization Network (AGSN) and the African Geodetic Commission (AGC).

Ethiopia is a country where the Afar depression (one of the two places on the earth, the other is Iceland) in the north east that a mid-oceanic ridge comes on to dryland and the main Ethiopian rift which bisects an uplifted region known as the Ethiopian dome in the central part and the southern rift in its southern part are situated. This rift system (Afar depression, the Main Ethiopian Rift, South Ethiopian Rift) and the adjacent plateau (the eastern plateau and the western plateau) (Fig 1) coincide with the spatial distribution of most of the seismic activity, volcanic activity, geothermal area and zones of mineralizationin the country.

It is therefore long recognized that the importance of gravimetric research must not be overlooked to supplement other fields of geological and geophysical research. Within this the study of the gravity field of a region could serve as an effective tool to delineate (active) zones of crustal deformation due to the dynamic process within the earth, assessment of their associated natural hazards (Earth quakes, volcanic eruptions, land slides, land subsidence and faulting) and in the search for economic minerals and energy resources. Gravimetric and other related researches in these regions should therefore be pursued with the view to meeting the current increasing demands for natural hazards assessment and natural resources search required by development and settlement programs of the country. Besides the immediate interest of a purely economical character, such as scientific research would also help unifying

Ethiopian geoscientists in their common effort to promote the science of gravimetry in the Country.

Vis-a-Vis the above facts, the new policy on exploration and evaluation of the Country's economic mineral and energy resources, the Ethiopian government has numerous implications. Among others it has direct bearing on economic development.

The major goal of this M.Sc research is generation (organization in a standard format), reduction and interpretation of gravimetric data collected so far (Alemu, 1992; EIGS, present data set) in the Southern Ethiopian Rifts and adjacent plateaus using updated methods and techniques that the present technology allows. Regional gravity field investigations made in the MER so far (Alemu, 1983, 1988, 1992; Gouin and Mohr, 1964; Searl and Guoin, 1972; Tessema, 1996; and others) are used as references to correlate the results of this Thesis work.

This attempt could therefore be regarded as a little contribution to the national challenge of the overall exercise in:

-the design and establishment of 1st order gravity station networks in the whole country.

-the collection and organization in a standard format of all gravity data in the Country.

-the production of standardized small scale (1:250,000) and large scale (1:50,000) gravity maps for the Country. Such maps serve to give a first hand information in the distribution, location and orientation of subsurface geological structures possibly related to economic minerals and energy resource deposits, when planning a detailed survey of a small region just in an equivalent way as geologic maps do.

With regard to its major goals, this Thesis describes the results of about 1800 gravity observations, obtained from two gravity data sources: EIGS (present data set) and Dr. Abera Alemu (Geophysical Observatory), made on the floor and shoulders of the SER between latitudes $3^0 30'$N and 7.15^0 N (Fig. 1) with the following objectives:

1. To compile reliable gravity data which will form a sound basis for further investigations of the Southern Ethiopian rift (SER).

2. To define the locations and magnitudes of the observed negative and positive Bouguer anomalies in the SER.

3. To investigate the continuity of axial positive anomalies in the Southern Ethiopian rifts, previously mapped by Abera (1992), in the MER, by Searl (1970) in the Kenyan Rift and by Makris (1975) in the northern part of the MER and the Afar depression.

4. To investigate the existence and nature of the broad negative Bouguer anomaly in SER which was previously shown to exist and be associated with the uplifted regions bordering the MER and the Kenyan Rift.

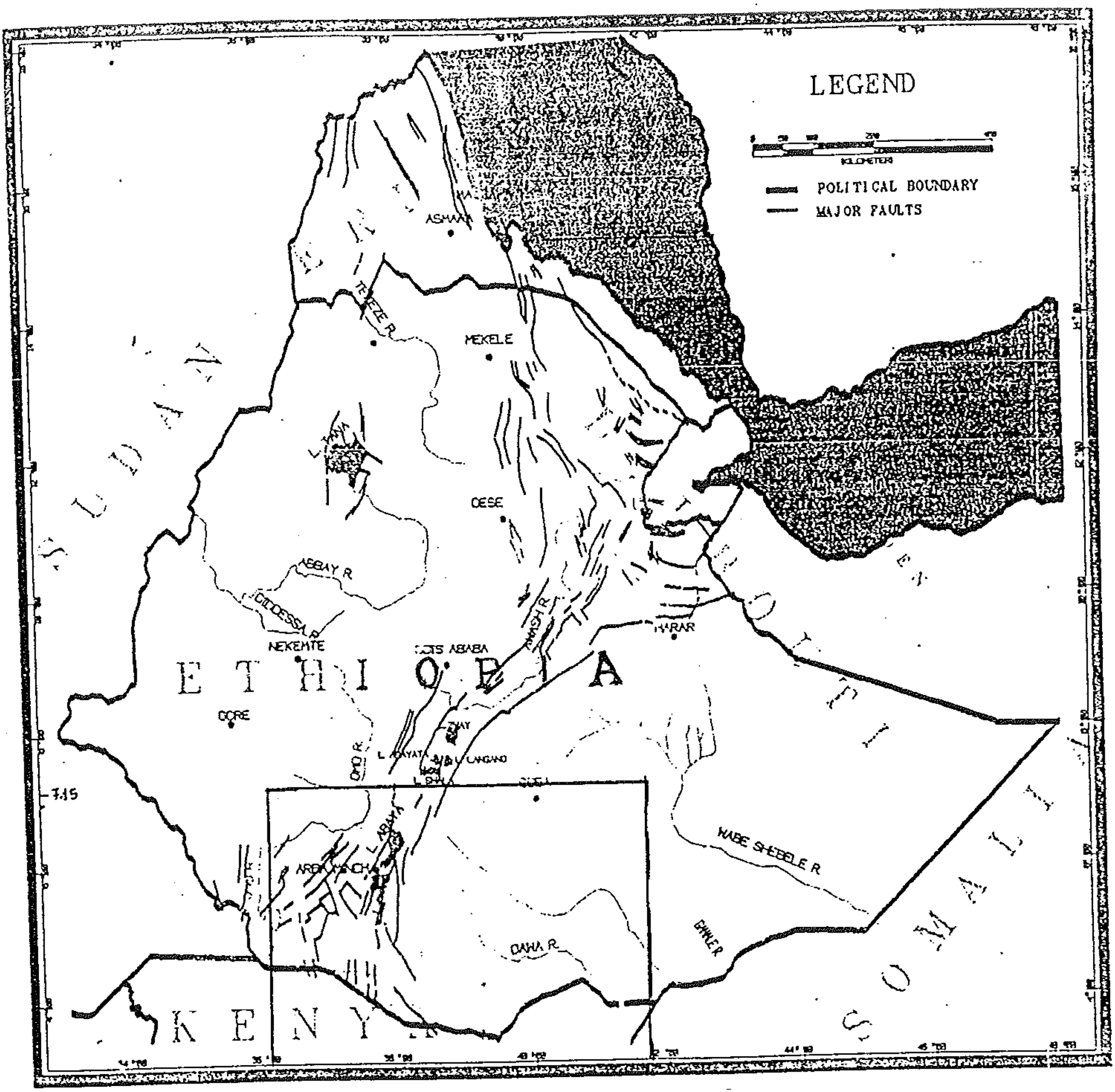


Fig. 1 Map of Ethiopia showing the major tectonic features of the rift system.
The study area is bounded by the rectangle.

CHAPTER TWO

2. PREVIOUS WORKS

2.1 GEOLOGICAL AND GEOPHYSICAL REVIEW OF THE ETHIOPIAN RIFT VALLEY

2.1.1 Extension of the Ethiopian Rift System along the rift zone in East African.

The Cenozoic Rift system of East Africa comprises a series of rift zones (Rosendahel, 1987) stretching approximately 3200 km from the Afar triple junction at the Red Sea - Gulf of Aden intersection to the Zambezi river in Mozambique. It is normally considered to be a continental extension of the global ocean rift ridge system (Baker and Wohlenberg,1971; McKenzie et al.,1970) being associated with a zone of shallow seismicity continuous with the Gulf of Aden and the Carlsberg ridge. The Ethiopian Rift System is a 1000km long structure running NNE ward from the Kenyan border to central Afar. It can be divided into three distinct sectors (Afar depression, the MER and SER) separated by tectonic/topographic discontinuities. The Main Ethiopian rift MER extends for about 650 km from the Lake Chamo region in the south ($4^0 45'$) to the region of Ayelu volcano in the north ($9^0 45$) beyond which its NNE trending structures are replaced by NNW trending structures of the Afar Depression.

At its southern end the MER is a pronounced feature in the vicinity of Lake Chamo. Further south wards, the MER disappears in the Konso upland where crustal extensions are displaced west ward into the southern Ethiopian Rift and the Turkana rift in northern Kenya (Alemu, 1992). In the SER segment, the East African rift zone occupies a width of at least 300km (Moore and Davidson, 1978).

2.1.2 Geological and structural review of the Main Ethiopian rift and southern Ethiopian Rift.

Since the initial work of Mohr (1960), the geological and structural history of the MER and SER has been documented by several authors (Mohr, 1960, 1962 a&b, 1967, 1972 and 1983; Di Paola, 1972; Baker et al., 1972). All the geological and structural descriptions that will be considered here is adapted from a summary of these previous studies by Alemu and Sjoberg (1990) and Alemu (1992).

The development of the MER is widely accepted to be due to the drifting apart of the western plateau and the eastern plateau to the west and east through tensional normal faulting.

Along its approximately 400km, the MER has a gentle curvilinear plan, convex to the west and widens out at its northern end to become identified with south western Afar. At its southern end, crustal extensions are transposed west into the southern Ethiopian Rifts and the Turkana Rift from which there is a southward continuation into the Kenyan Rift (Mohr and Wood,1976; Alemu,1992).

The Turkana Rift extends north up to the lower part of SER. The SER is a tectonic depression where Precambrian rocks are locally exposed in its floor and extends into the western flank of the Main Ethiopian rift. The Main Ethiopian Rift begins at about latitude $4^0 45'$, where the Amaro Horst, which is bounded by rejuvenated faults to the east, declines abruptly at its northern end, where the rift widens to about 60kms. Five large rift Lakes of tectonic or volcano-tectonic origin (Ziway, Langano, Abiata, Shala and Awasa) occupy the central part of the Main Ethiopian rift. West of the rift Lakes, major faults appear, which trend to the typical NNE-NE rift direction between 8^0 and $8^0 30'$N, the Guraghe escarpment which is 35km long with a vertical displacement exceeding 1500m, forms the western margin of the rift. The eastern escarpment has a vertical throw between 500m and 1000m relative to the rift floor. East of Lake Awasa, a strongly denuded older fault scarp shows a late Miocene - Pliocene down warping of the eastern plateau into the rift. Further north, the eastern escarpment is strongly upwarped rift wards in the chain of the rift lakes from the Katar basin of the eastern plateau. This strongly stepped escarpment is formed by a complex of NNW and NNE trending Pleistocene faults. At about latitude $7^0$30'N (in the vicinity of lake Shalla, Abyata and Langano), these faults coincide with part of a huge crater like feature.

Extensive basaltic plateau volcanism began in the early Miocene in Ethiopia and extended to the Turkana rift. The first major step of rifting was initiated some what later, during the mid - Miocene in Ethiopia and the early Pliocene in Kenya. This faulting was accompanied by renewed volcanism (rhyolite and trachyte volcanism) becoming more centrally located along the axis of rifting.

Major domal uplift occurred in the late pliocene and Quaternary accompanied by the formation of deep grabens and further alkaline volcanism. The Main Ethiopian rift is centrally located in the crest of the broad uplift of the Ethiopian dome, between the Ethiopia and Somali plateaus. By the Pleistocene the proto rift was a topographically shallow trough (Baker and Mitchell, 1976) with deep infilling of silicic volcanic erupted from volcanic centers close to the rift margins. Mohr (1966b) suggested that the marginal faults are pleistocene in age and the separation of the Ethiopian plateau to the west and the Somali plateau to the east occurred at this time. Fragmentation of the rift floor formed the youngest structural deformation largely concentrated within a narrow, 5-12km wide belt of normal faults, known as the Wonji Fault Belt (Mohr et al.,1980; Lioyd, 1977). The Wonji Fault Belt (WFB) maintains NNE orientation along the entire length of the MER and has been forced into en - echelon offsets in order to remain within the rift margin envelop. The displacement lines of this fault belt (WFB) are sites of maximum shallow crustal heating; this can be deduced from the present geothermal activity, the associated observed positive gravity anomalies and the quantities of volcanic products and their compositions.

2.2 GRAVITY DATA INTERPRETATION

2.2.1 The Main Ethiopian Rift (MER) Anomaly Belt

The Main Ethiopian Rift (MER) forms a part of the East African Rift (EAR) system which has only been recognized as a continental extension of the World Rift System (Ewing and Heezen,1956). Regional gravity field investigations across the rift zone in East Africa have shown long wave length (broad) negative Bouguer anomalies with superimposed short wave length (narrow) positive anomalies over the rift axis. The regional negative anomalies are interpreted by Girdler et al.(1967), Girdler and Sowerbutts (1970), and Baker and Wohlenberg (1971) in terms of an upward thinning of the lithosphere and replacement by lower density astenosphere beneath the East African uplifted regions. The axial short wave length positive anomalies are interpreted by Searl,(1970) as being due to intrusive zones in continuity with the lower density astenosphere (i.e extreme thinning of the lithosphere beneath the rift floor in East Africa).

The later conclusion is also in accord with various earlier works, and probably indicates a mantle plum activity underneath the MER centered at the Lakes District and the positive anomaly belt, which is the expression of the MER, is most likely the effect of the intrusion of a high density mantle material into the crust. The intrusion could have caused a general isostatic imbalance in the area of the proto - rift, in response to which successive collapsing and subsidence of the overlying mass might have resulted in the formation of the MER.

Several authors have discussed the gravity anomaly over the MER. The presence of the axial positive anomaly was first recognized by Gouin and Mohr (1964) who suggested that it was caused by "denser" material or "thinner crust" beneath the Ethiopian rift system. In the Ph.D work of Alemu (1992), which incorporates a fair density of gravity data shows that, the axial positive anomaly first recognized by Gouin and Mohr exists along all segments of the MER following the Wonji Fault Belt (fIG.2).

A linear Bouguer gradient of +0.35 mgals/km southward has been recognized on the somalia plateau, south of the E-W kofele - Adaba syncline. As with the 0.2 mgal/km gradient over the northern Ethiopian plateau (Mohr & Rogers 1966), it is tentatively attributed to change in crustal thickness and/or to thickness of underlying anomalous mantle material. In both regions the postulated crustal thickening is towards the center of the Ethiopian swell.

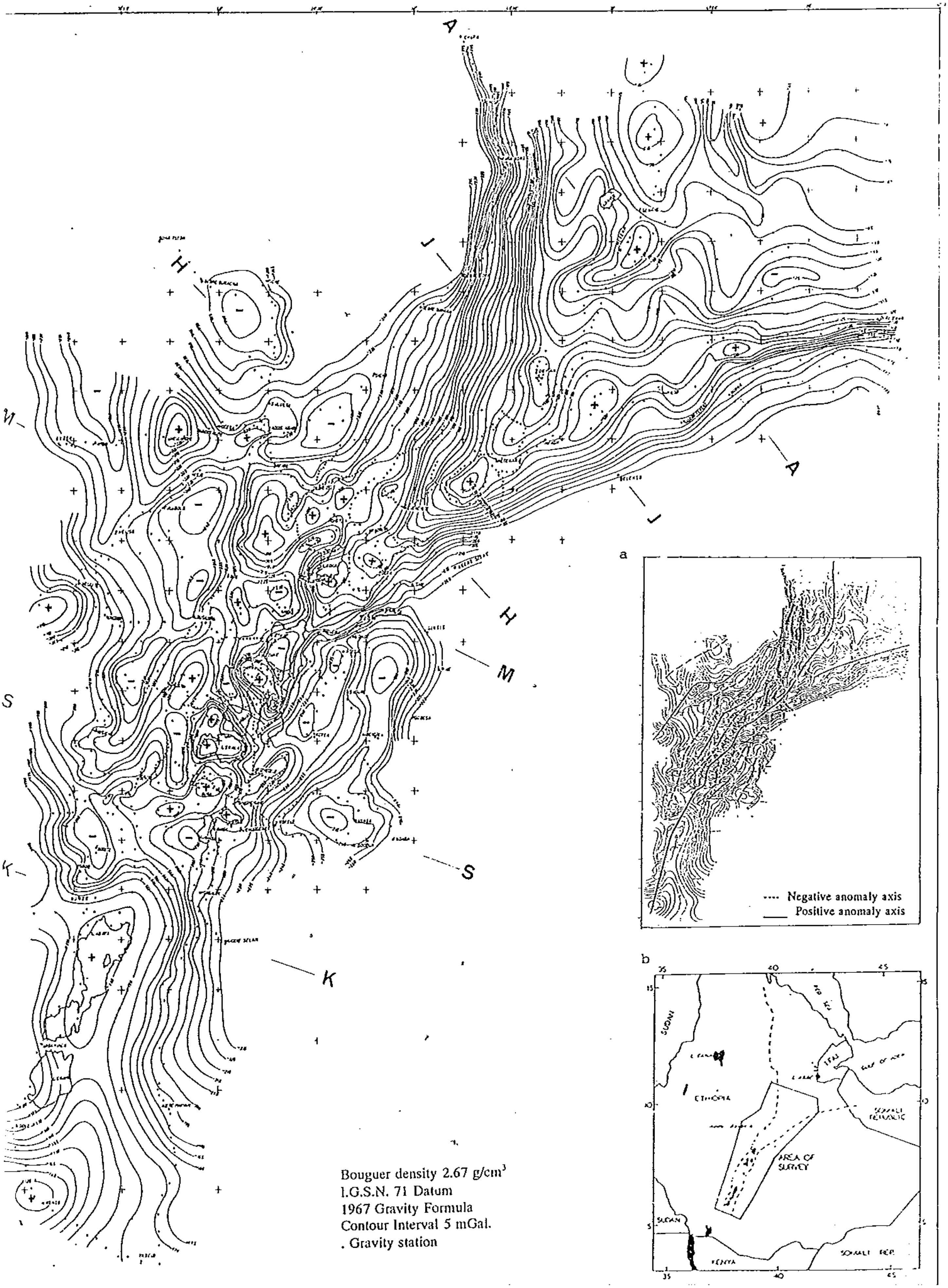
Gravity 'high' occur immediately north of major cross - rift transcurrent rifts (Mohr 1967), including a newly proven one displacing the main Ethiopian rift south of Lake Chamo from the from the Chew Bahir rift.

Gouin (1970) subdivided the Bouguer gravity field of the MER into three components as the broad negative, the relatively positive and the narrow positive anomalies associated respectively with the Ethiopian dome, the rift floor and with the local tectonic features. He attributed the broad negative anomaly to a low density upper mantle material (possibly asthenosphere) underlying the MER; the relatively positive anomaly to "mass deficiency providing isostatic balance of the regional uplift to match the lower elevation of the rift floor and cause a relative positive anomaly"; and the local narrow positive anomalies of the rift floor to the Wonji fault belt.

Kazmin (1972a) also stated that "the Main Ethiopian Rift is characterized by a negative gravity anomaly as is the case with all East African rifts (Baker et al, 1972)". He attributed this anomaly to a low density layer in the upper mantle or the lower crust.

Purcel (1981) suggested that the "Main Ethiopian Rift valley is characterized by a relative broad positive gravity anomaly. In the area of the rift, extending from Lake Awasa through the lakes district into the Addis Ababa embayment, the gravity anomaly of the rift valley is characterize by a series of linear positive and negative anomalies. Alemu (1992) confirms Purcel's work by describing this trend of alternating positive and negative anomalies to extend from a few tens to several handreds of kilometers in a NNE - SSW direction. He further explaned that the positive axes are alined over the rift floor and the marginal grabens, while the negative axes are associated with the elevated regions of the plateaus, where the structures delineated by these gravity trends appear to be alternating bands of grabens and horsts (Fig.2)

The authors cited above had based their conclusions on the interpretation of Bouguer anomaly maps.



gure 8: Bouguer anomaly map of The Main Ethiopian Rift and the adjacent plateaus. Insets show (a) gravity trends over the study area and (b) location map of the study area.

(Adopted from Abera, 1992)

CHAPTER THREE

3.GEOLOGY AND TECTONICS OF THE MAIN ETHIOPIAN AND SOUTHERN RIFT SYSTEMS

3.1 The Main Ethiopian Rift System

The symmetrical Main Ethiopian Rift system (MER) is bounded by steep boundary faults and uplifted shoulders (Wolde Gebriel, et al, 1990) and extends for about 450Km from Lake Chamo in the south to southern Afar in the north (Meyer, et al, 1975).

The MER begins in clear morphological depression south of Lake Chamo (Meyer, et al, 1975), but in the north no clear boundary exists. However, according to Mohr (1971), the MER opens out wards into southern Afar at about the latitude of Addis Ababa.

Mohr (1971) subdivided the MER floor into two parts at the main watershed between Awash river and Lake Zway. There is general grading of the southern rift floor extending from the watershed up to Lake Chamo, with the exception of Lake Awasa basin which is generally elevated above the rift floor (Mohr, 1971). The northern portion, north of the watershed, extends northwards to merge into southern Afar.

The MER floor consists of three caldera - related basin connected by the volcano tectonically active Wonji fault belt (Wolde Gebriel, et al, 1990): Zway - Langano - Abayata, Shalla - Awasa and the Bilate river drainage basin.

In the northern part of the MER, two volcano - tectonic units can be clearly identified (Meyer, et al,1975): the Nazreth series and the Wonji series.

The Nazreth series extends from the Gregory rift in Kenya through the MER floor to south Afar and the southeastern escarpment (Baker, Mohr and Williams, 1972). It is composed of silicic rocks such as ignimbrites,rhyolites and pumice. The age of this unit is 5 - 2 m.y and its known thickness is not more than 150m. The Nazreth series is overlain by lacustrine and fluvatile sediments.

The younger unit, the Wonji series, is of pleistocene to Holocene age and lies with an unconfirmity over the Nazreth series. The Wonji series rocks, mainly consisting of basaltic flows as well as some silicic and intermediate rocks, are generally located near the Wonji - fault belt (Meyer, et al, 1975; Mohr, 1971).

The Wonji series is divided into two parts: the lower and the upper parts (Meyer, et al, 1975). The lower part, characterized by the Wolenchiti basalt and its accompanying basaltic rocks, adheres strongly to the NNE - SSW striking fractures and fissures. The upper part lies over the Wolenchiti basalt with an unconfirmity, and a thick layer of loam is situated between the two.

The Nazareth and Wonji series rocks are divided in time by the main Nazareth - faulting phase which appeared during 1.6 - 1.8 m.y (Meyer, et al, 1975). The first faulting phase took place during the deposition of the Nazareth series, and is characterized by tensional stresses perpendicular to the MER. This has resulted in NE - SW and NNE - SSW trending tectonic patterns: fractures, fissures, dykes, etc. The main Awash - Meki watershed (Mohr 1962b) was developed parallel to this stress, and has formed a tectonic line characterized by volcanic and hydrothermal activity and tilting of the adjacent areas (Meyer et al, 1975). The second main faulting phase has resulted in the development of the Wonji fault belt along with the groups of fractures, open fissures and dykes showing NNE - SSW and N - S direction, and mainly composed of basaltic rocks.

In the south, the group of Wonji faults follow NNE - SSW direction. In the north, this trend of the Wonji faults cut across the NE - SW trend of the MER indicating the development of a certain shearing effect (Gibson, 1969; Gibson and Tazief, 1970). Meyer et al (1975) however stated that the main tectonic stress hitherto has been only tensional and no shearing pattern can be observed in outcrops.

By and large, during the Nazareth phase, and with the development of the Wonji fault, strong rifting and plate movement began and intense fracturing might have resulted in the development of plate boundary underneath the MER (Meyer et al, 1975).

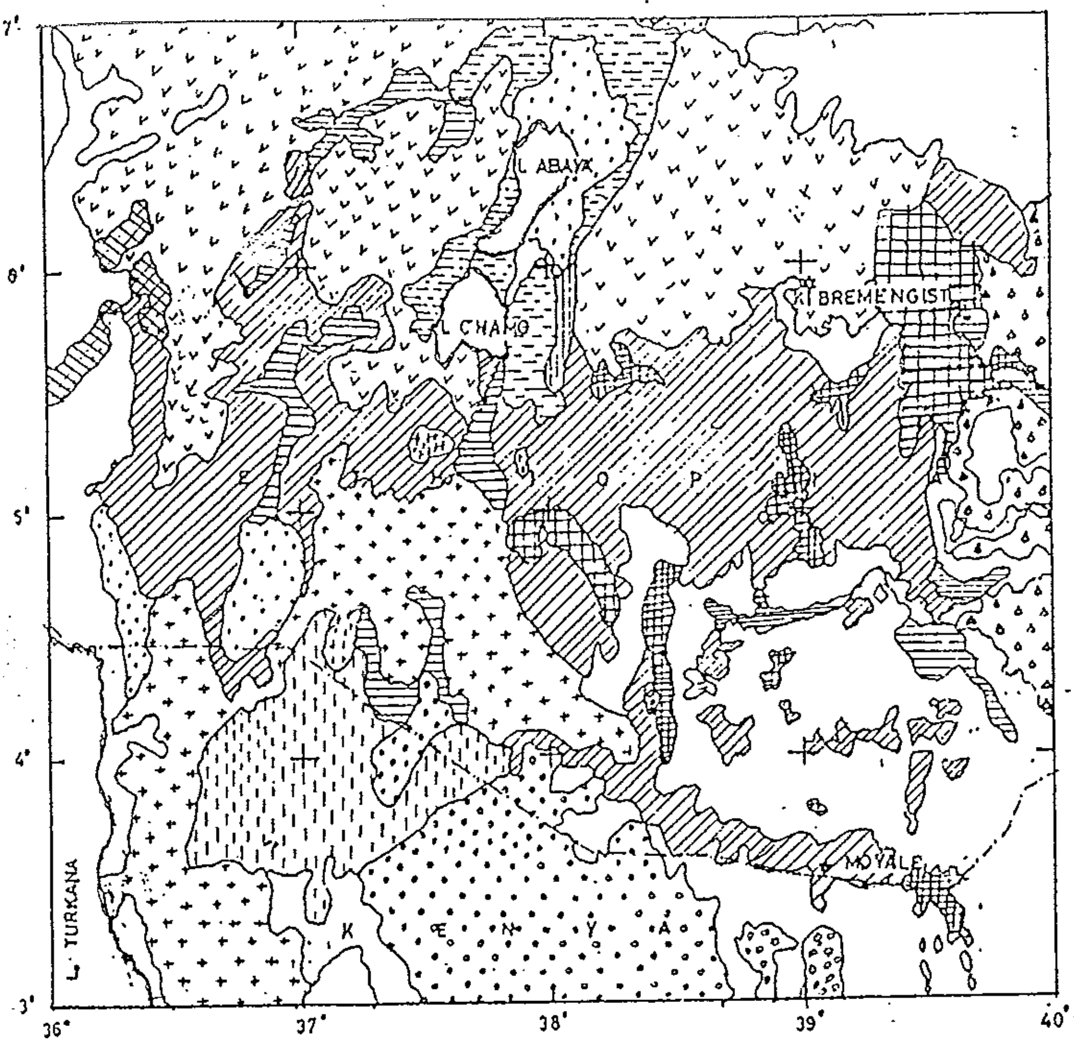
3.2 The Southern Ethiopian Rifts

South of the MER and north of the Turkana rift in Kenya, the East African rift zone consists of three major rift valleys and a Basin-and - Range province (Moore and Davidson, 1978) - the **Chew Bahir, Omo** and **Kibish** rifts, and the **Gofa Basin -and -Range province**

The **Chew Bahir rift** is bounded by steep and serrated fault scarps trending in a general NNE - SSW direction. This rift has an average width of 40km and lies at an altitude of 520m above sea level (Mohr, 1971).

The Chew Bahir rift is located east of the huge tilted basement block the Hammar Horst which dips in a W - SW direction underlying layers of basalt and pliocene to resent beds of the Omo river valley (Moore et al, 1978). In the north, it is successively interrupted by the Woito Horst and the Gofa Basin - and - Range province.

The **Omo rift** is a poorly defined broad half graben lying on the border of Ethiopia and Kenya (Moore et al, 1978; Mohr, 1971). On the west, it is bounded by major faults



High-grade metamorphic: granitic and feldspathic gneiss; biotite and amphibole gneiss; rare granulites;migmatites; amphibolites; quartzites. (precambrian: upper proterozoic)

Lacustrine and swamp deposits; volcano lacustrine deposits of the rift floor.(pleistocene to present)

Alluvial deposits. (pleistocene to present)

Eluvial and Colluvial deposits, talus, sheet floods, dunes and beach deposits. (pleistocene to present)

Turkana-Teltale fissural basalts. (Oligocene to Miocene)

Fissural basalts. (Pliocene)

Basalts, mainly fissural. (Quaternary)

Jima volcanics: abundant rhyolities and trachy basalts. (Oligocene to Miocene)

Ignimbrites and pumices of the rift floor and subord, lacustrine deposites. (Pliocene)

Adigrat sand stones: Variegated, quartzose sand stones, of fluvial and/or littoral origin. (Trias to dogger)

Rhyolites in thick sheets and domes. (Pliocene)

Granites and quartz-diorites. (Lower palaeozoic and Precambrian)

Hamanler and iscia Baidoa formations: organogenic and olitic limestones (Callovian to oxfordian)

Fig3 Geology map of the study area (southern part of Ethiopia). (adapted from the "Geologic Map of Ethiopia and Somalia" (Merla et al, 1973.)

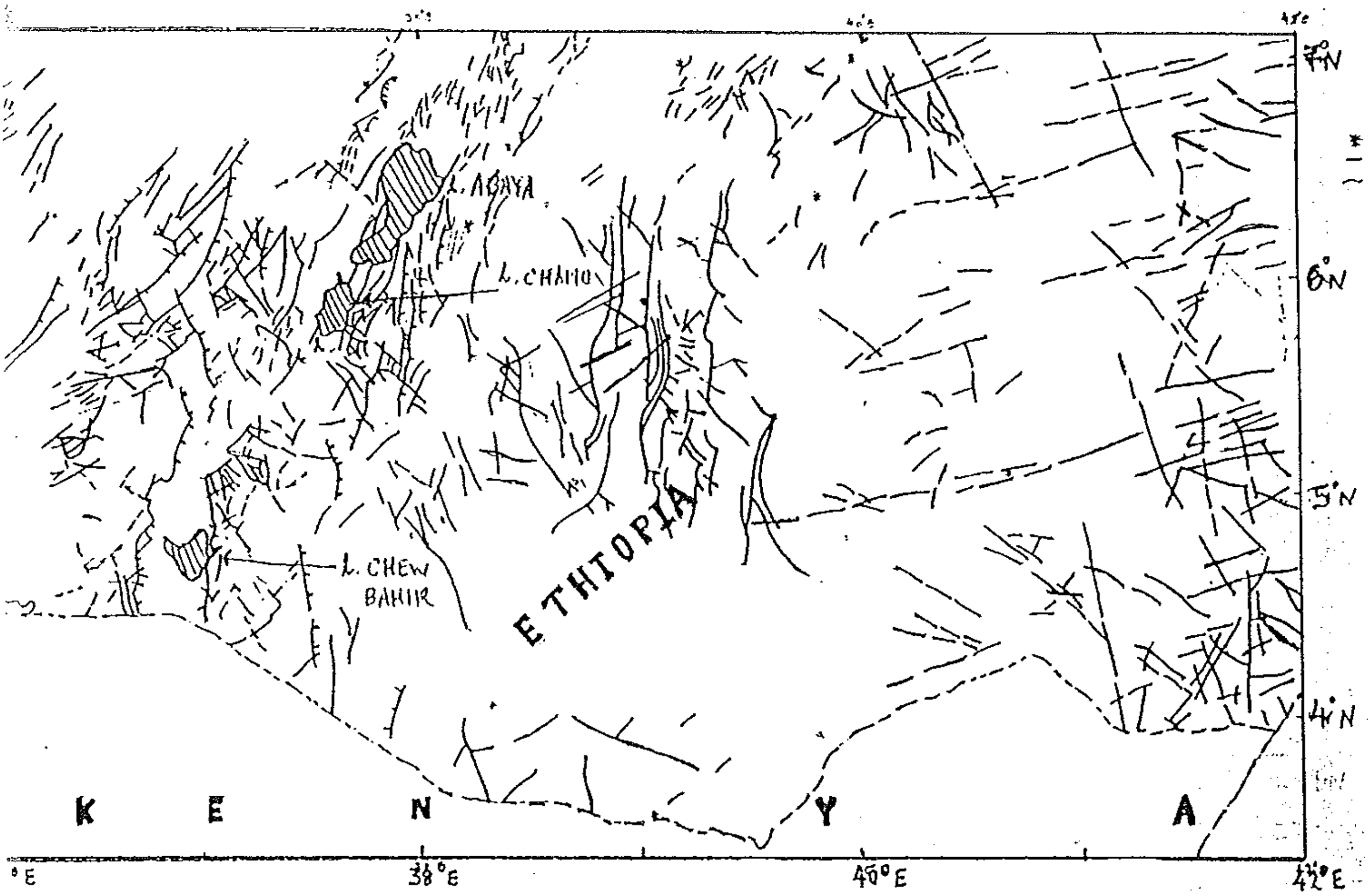


Fig.4 Tectonic Map of the study area.

– fault

▧ Lakes

--- National border lines

striking N and NE along the eastern side of the Illibai Horst (Moore, et al, 1978). To the east lies the Hammar block tilting west, towards the rift basin. The Omo rift has been subjected to complex extentional fault which have been exhibited by seismicity, Tertiary volcanism and sedimentation which are directly the evidence of extentional stress undergoing in the region (Moore and Davidson, 1983).

The Chew Bahir and Omo rifts appear to be the projection of the MER System, however they are apparently discrete Cenozoic Rift Systems (Tessema, 1996) which is contrary to Moore and Davidson's (1983). The well defined West ward tilted Omo rift basin traverses a total length of about 600 km and width of 50 to 60 km and 1km deep. Its northern end is defined by narrow and diminishing vertical throw. The southern extension is marked by broad depression and links to the Turkana rift in Kenya. Major fault escarpments are well preserved at the eastern flank and they are ranging upto 1.5 km deep from the foot of the rift floor. The south eastern margin of the faults are exhibited as a set of two or more segmented normal faults. Here the altitude of the rift floor falls below 600 m and the faults splay out over a width of 200 km or more whereby the rift losses its graben appearance.

The multistage faulting which bounds the rift characterizes the area as step faulted sedimentary basin flanked by steep escarpments. The trough is bounded along one or both sides by normal faults showing large vertical displacements. The broad flat plane of the rift is covered by sediments which blanket the entire floor of the Omo rift to the west and Waito and Chew Bahir Rifts to the east. Faults striking ENE cut late Miocene to Pliocene age volcanic rocks predominantly basaltic, rhyolitic and trachitic rocks which are bounding the rift basins (Davidson, 1983).

According to More (1992), the typical process of crustal extension, marked by magma passing up through the crust in the case of Omo and Chew Bahir rifts, have generally been predicted due to the following sequence of events which took place in the region.

1. Pre - rift topography, with axis of broad, gentle uplift rarely faulted.

2. Massive flood basalt eruption accompanied by subsidence of broad proto - rift depression. Parallel sets of fissure dike feeders are located at the Omo rift.

3. flood basalt eruption terminated except

-For minor eruptions mainly silicic, example rhyolite volcanic at the south western end of Chew Bahir rift.

-Large eruptions from restricted fissure zones outside the depression; example, basaltic lava flows at the north western margin of Omo rift.

4. Differential uplift produced domal plateaux embracing the lava- pan depression; example, both north eastern and north western margins of the rift basins. This uplift occurs in discrete opisodes that continue into Quaternary.

The Kibish rift is a subordinate half - graben bounded in the west by the Illibai Horst. In the east, it is separated from the Surma Horst by a steep fault scarp. The Kibish and its adjacent Surma block are in part terminated along strike by northeast-striking normal fault (Moore et al, 1978).

CHAPTER FOUR

4. THEORY

4.1 BASIC THEORY OF GRAVITY

Force that exists between two bodies separated by distance r is give by :

$$F = Gm_1m_2/r^2 \qquad 1$$

A material body at a given height above the surface of the earth moves toward the ground when released freely from a state of rest. The force of attraction between the material body and the earth is:

$$F = GMm/r^2 = mg \qquad 2$$

The force per unit mass acting on the body causing it to move towards the surface of the earth called gravity or gravity field of the earth is given by:

$$g = GM/r^2$$

The terms, gravity force, gravity field and gravity shall interchangably used here to mean the force per unit mass acting on a body.

The possible forces acting on a body of mass m moving with velocity v on the surface of a rotating spherical earth of mass M and radius R are:

-The force of attraction g_a given by:

$$g_a = GM/R^2 \qquad 3$$

-The centrifugal force due to the rotation of the Earth with angular velocity w about its axis of rotation given by:

$$f_{cg} = -\omega^2 R \qquad 4$$

and the z-component is

$$(f_{cg})_z = -\omega^2 R \cos^2 \Phi$$

-The coriolis force due to its motion on the surface of the Earth given by:

$$f_{cor} = 2\omega x\, v \qquad 5$$

In ground gravimetry, Since observations are taken with gravimeter that is resting stable on the surface of the earth, v=0, Hence the coriolis force acting on the gravimeter (body) is zero. The total force acting on the body (gravimeter) is therefore the resultant of the attractive and centrifugal forces and is known as the force of gravity given by:

$$g = \frac{GM}{R^2} - \omega^2 R \cos^2 \Phi \qquad 6$$

To determine the gravity field of the Earth at a point on its surface we must know its shape and density distribution. Due to the centrifugal force, the Earth departs from a spherical shape; it is bulged at the equator and flattened at the poles. That is, the effect of the centrifugal force gives the earth the shape of an ellipsoid of revolution, i.e, a surface generated by the rotation of an ellipse about its minor axis with the major axis generating the equatorial plane.

Thus, for describing the earth's shape, one usually uses a reference an ellipsoid of revolution with z-axis coinciding with the axis of the earth's rotation and xy-plane with the equatorial plane (Sjoberg, 1990). The equation for such an ellipsoid reads:

$$(x^2 + y^2)/a^2 + z^2/b^2 = 1, \qquad 7$$

Where a is the semi-major axis and b is the semi minor axis. The flattening (f), the first and second eccentricity (e,e') of the ellipsoid are defined as:

$$f = (a - b)/a, \quad e = (a^2 - b^2)^{1/2}/a \ \text{ and } e' = (a^2 - b^2)^{1/2}/b$$

and these parameters are used to describe the deviation of an ellipsoid from a sphere, which has $f = e = e' = 0$.

The splitting of the gravity field into a "normal" and a remaining small "disturbing" field considerably simplifies the problem of its determination (Heiskanen and Moritz, 1967). Therefore we assume that the ideal reference ellipsoid, which is related to the mean sea level surface with excess land masses removed and ocean deeps filled, is an equipotential surface of a normal gravity vector field. Denoting the potential of the normal gravity field by

$$U = U(x, y, z), \qquad 8$$

We see that the reference ellipsoid is a surface with

$$U(x, y, z) = Uo = \text{constant}.$$

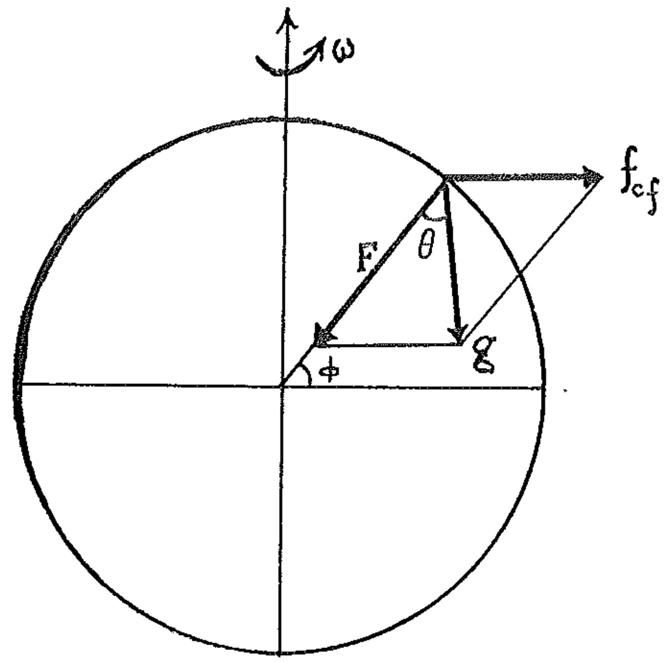


Fig.5 The components of the gravity force: attractive (F) and centrifugal (f_{cg}) force, assuming a rotating spherical Earth.

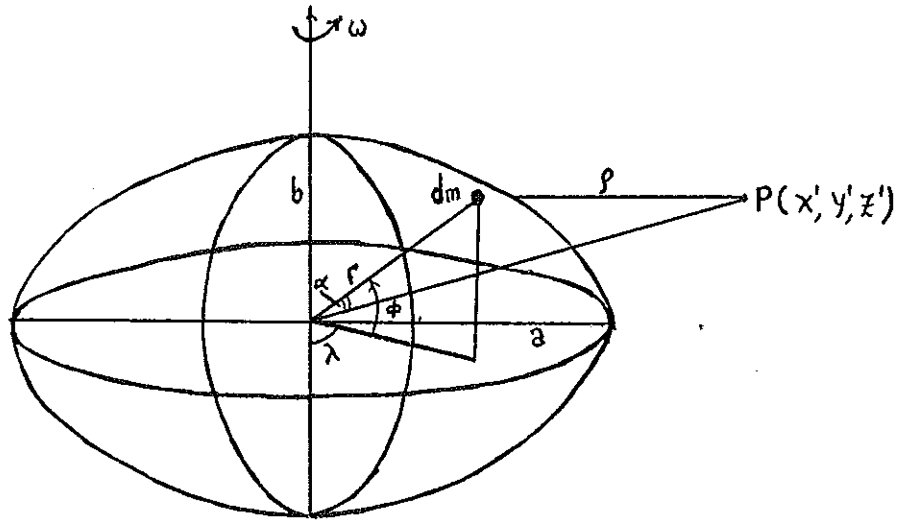


Fig.6 Figure of the Earth. a, equatorial radius; b, polar radius; f latitude; Xλ longitude and ω angular velocity of the Earth.

The potential (U) of the normal gravity vector field is the sum of the attractive potential (V) and the centrifugal potential (ϕ):

$$U = V + \Phi = G\int_v \frac{dm}{\rho} + \frac{1}{2}\omega^2(X^2 + Y^2).$$

The normal gravity vector γ_ϕ at a given latitude f on the reference ellipsoid is the gradient of U:

$$\gamma_\Phi = gradU$$

Whose magnitude is the normal gravity and the direction is that of the plumb line, i.e., the plumb is vertical at all points on the equipotential surface. For an external point P(x', y', z') (Fig.5), that rotates with the earth at an angular velocity ω about the z-axis,

$$U = G\int v\, dm/\rho + \tfrac{1}{2}(x'^2 + y'^2)\omega^2 \qquad 9$$

and

$$\frac{1}{\rho}=\frac{1}{r'}[1-\frac{2r}{r'}\cos\alpha+\frac{r^2}{r'^2}]^{-\frac{1}{2}}$$

Provided (2 (r/r')cosα $-r^2/r'^2$) be less than 1, the bracketed quantity may be expanded using the binomial theorem to give

$$\frac{1}{\rho}=(\frac{1}{r'})[P_0(\cos\alpha)+(\frac{r}{r'})P_1(\cos\alpha)+(\frac{r}{r'})^2P_2(\cos\alpha)+...]$$

and

$$U=\frac{G}{r'}[\int_v dm+(\frac{1}{r'})\int_v P_1(\cos\alpha)rdm+(\frac{1}{r'^2})\int_v P_2(\cos\alpha)r^2dm+...]+\frac{1}{2}(x'^2+y'^2)\omega^2$$

where the functions Pn(cosα) are Legends polynomials. Using the definition of moment of inertia in mechanics one can arrive at

$$U = MG/r\ (1 + (k/2r^2)(1-3\sin^2 f) + w^2\ (r^2/2MG)\cos^2\phi),$$

Where M is the total mass of the earth, and k is a constant determined by the moment of inertia about x, y, z axes and the mass M (Garland,1979, Tsuboi, 1983; Telford et al., 1990, Heiskanen and Moritz, 1967). Hence, one can easily Show that the normal gravity (theoretical gravity) value, γ_ϕ as a function of the latitude angle, ϕ, at any point on this ellipsoid is given by

$$\gamma_\Phi = \gamma_0 (1 + B_1 \sin^2\Phi - B_2 \sin^2 2\Phi)$$

Where γ_o is the value of $\gamma\phi$ at the equator $\phi=0$, B_1 and B2 are constants. Making use of all the observed value of g at a number of points over the earth, numerical values of the constant B1 and B2 have been determined in 1930 by the International Association of Geodesy (IAG) and adopted the formula known as **the 1930 International Gravity Formula** given by:

$$\gamma_{\Phi 1930} = 978049(1 + 0.0052884 \sin^2\Phi - 0.0000059 \sin^2 2\Phi) mGal$$

with γ_o = 978049 mGal, equatorial radius a=6378.388 km, polar radius b=6356.909 Km, the elipticity (polar flattening) given by f=(a-b)/b = 1/127.

Recent studies on the orbits of satellites have provided more precise values for constant B1 and B2 and the following is the revised theoretical gravity formula established by IAG in 1967

$$\gamma_{\Phi 1967} = 978031.85(1 + 0.0053024\sin^2\Phi - 0.0000059\sin^2 2\Phi)mGal \qquad (17)$$

With γ_o = 978031.85 mGal, a=6378.160 Km, b=6356.909 Km, and f=1/129.25.

Even in its most refined state, the standard theoretical gravity formula is a very crude approximation. It assumes that there are no undulations on the earth's surface, where as, in fact we have elevated lands (hills) and oceanic depressions. Hence, for a practical work, i.e., measurement of gravity on the physical surface of the earth we must define a physical equipotential surface on the Earth. This physical surface is known as the **Geoid**. Geoid is a surface such that gravity g is perpendicular to it. It is a zero reference (elevation datum h = 0) for elevations and ocean depths, as given on topographic maps.

Geoid is the undisturbed mean sea level surface continued into continents so as to encircle the earth, water seeking its level in imaginary shallow canals until it is at rest.

The value of gravity at a point calculated by a standard theoretical formula and that observed and reduced to the geoid do not agree with each other. This is because the effect of attraction of an invisible anomalous mass under the point is involved in the observed value. The small deference between the actual gravity potential W and the normal (theoretical) gravity potential U is denoted by T (fig.7) (Heiskanen and Moritz, 1967). so that

$$W(x, y, z) = U(x, y, z) + T(x, y, z)$$

T is called the anomalous potential, or disturbing potential. For small regions T is negligible. We compare the potential on the geoid

$$W(x, y, z) = Wo$$

with the potential on the reference ellipsoid

$$U(x, y, z) = Uo$$

of the same potential Uo = Wo. Consider now the gravity vector g_p at a point P of the geoid (Fig. 7) and the normal gravity vector γ_Q a point Q of the ellipsoid. The gravity anomaly vector (Δg) is defined as their difference:

$$\Delta g = g_p - \gamma_Q$$

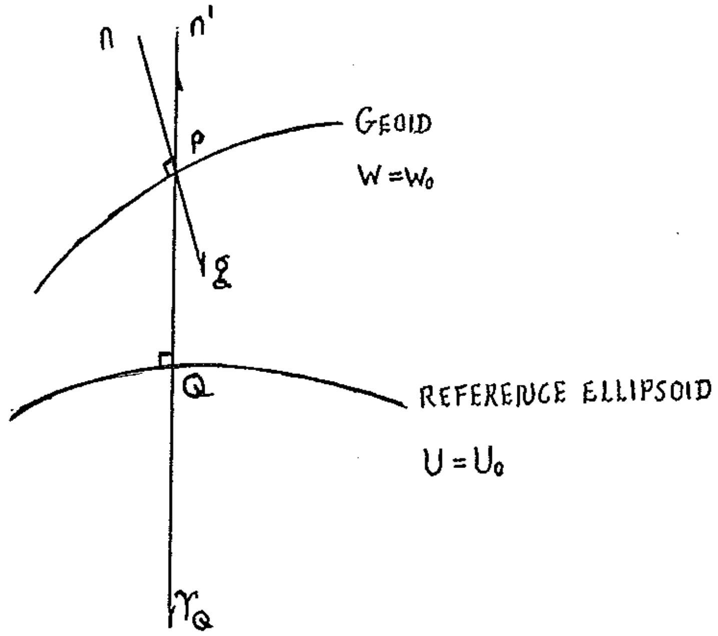


Fig.7 Geoid and reference ellipsoid. n and n' are the unit normals to the geoid and ellipsoid respectively.

A vector is characterized by magnitude and direction. The difference in magnitude is the gravity anomaly given by

$$\Delta g = g_P - \gamma_Q$$

the difference in direction is the deflection of the vertical (θ). Here, g_p is the gravity value observed (g_{obs}) at a point on the surface of the Earth and reduced to the geoid point (P). γ_Q is the theoretical gravity value on the ellipsoid point (Q).

Gravity anomalies developed as a consequence of deference's in the density distribution of the earth, particularly in the upper layers known as the crust. Therefore they reflect the internal constitution of the crust and indicate the presence of various geological structures connected with the dislocation of rocks of different densities. This enables us to study the internal structure of the Earth and for gravity prospecting.

4.2 THE REDUCTION OF GRAVITY DATA

We are not interested in anomalies produced by differences in elevation between the observation points and therefore have to reduce the observed gravity values to values in corresponding points on the geoid. Next we have to correct the data for the effect of isostasy and tidal effects of moon and sun. The remaining anomalies will be due to density contrasts of the rocks, caused by folding, faulting, mineral accumulation (ore, saltdomes), intrusions, etc., in general to geological phenomena in which we are interested in our exploration of the subsurface. With this theoretical back ground the data obtained from EIGS were checked if they were connected to IGSN-71 datum. There after point gravity values were reduced to the geoid by applying free-air and Bouguer corrections according to the following theoretical scheme.

4.2.1 The "free air" correction

This is a correction for the difference in gravity between observation point and the corresponding point on the geoid due to the difference in elevation, i.e. for the effect of a greater distance of the observation point from the center of the earth. The space between the level surface and the geoid is assumed to be empty. The curvature of the earth and difference in centrifugal force is negligible. In my case this correction has been applied to the observed gravity values.

At sea level:

$$g_o = G\frac{M}{R^2}$$

Where M is the mass of the earth and R is the radius of curvature (distance center of the earth to corresponding point on the ellipsoid).

At elevation h:

$$g = G\frac{M}{(R+h)^2} = g_o\frac{R^2}{(R+h)^2}$$

The difference is: (as h is much smaller than R)

$go - go\,R^2/(R + h)^2 = go[1 - R^2/(R + h)^2] = 2gohR + goh^2/(R + h)^2 \approx 2goh/R$

If we use Jeffrey's (1952) values for the earth's radius and corresponding values of g from the international gravity formula, we find:

latitude in degree	2g/R at sea level in mgal/m
0^0	-0.3067
45^0	-0.3080
90^0	-0.3093

In practice we take $2g_o/R$ = 0.3086 mgal/m based on $R_{average}$ = 6367 km ($R_{equator}$ = 6378099m, R_{pole} = 6356631m, and g = 980gal). For all exploration purposes this is sufficiently accurate.

$$\delta g = (\delta g)_F = 0.3086 h\, milligal$$

is called the free-air correction.

When the point of observation is above mean sea level, the free air correction has to be added to the observed gravity value and subtracted for observation points below mean sea level. The resulting anomaly:

$$\Delta g_F = g_{observed} + (\delta g)_F - \gamma$$

is called the free air anomaly.

It gives an indication of the deviation of the real earth from the homogeneous ellipsoid, when the topography above mean sealevel would have no mass. A zero free air anomaly would mean complete isostasy.

4.2.2 The Bouguer correction

We again ignore the earth's curvature and assume the mean sealevel to be a flat surface. Let the elevation of point P be h and takes it as the origin of a cylindrical coordinate system.

the attraction in P of a volume element dv=dzdrrdf with density

ρ is

$$G\frac{\rho dz dr r d\Phi}{(r^2+z^2)}$$

of which the vertical component is

$$\frac{G\rho dz dr r d\Phi z}{(r^2+z^2)^{\frac{3}{2}}}$$

The Bouguer correction is obtained by integrating over the entire slab. The horizontal components of the attraction between the mass particles and the unit of mass in P cancel each other and we find for the Bouguer correction:

For all data obtained from EIGS and Abera are reported that no terrain correction has been applied. Since the survey area is not so much ragged, neglecting the terrain effect in the survey area is assumed to cause an error not greater than 2mGal in the simple Bouguer anomaly. According to Alemu (1992) the mean terrain effect computed at points along two profiles which traverse the summit of Aluto volcano (2335m above sea level and rises by about 700m above the rift floor) in an E-W and N-S direction amounts to about 2.0 mGal. This 2mGal error due to neglect of terrain correction is treated as a systematic error in computing the over all mean square error of the simple Bouguer anomaly.

$$\int_0^{2\Pi}\int_0^{h}\int_{r=0}^{\infty}\frac{G\rho rzd\Phi dzdr}{(r^2+z^2)^{\frac{3}{2}}}=\int_0^{2\Pi}\int_0^{h}-\frac{1}{r^2+z^2}\Big|_0^{\infty}G\rho zd\Phi dz=G\rho\int_0^{2\Pi}hd\Phi=G\rho h2\Pi$$

$$(\delta g)_B=0.0419\rho h$$

The Bouguer correction removes the effect of the slab between mean sealevel and the parallel surface through the observation point and therefore, for observations on land, has to be subtracted from the observed gravity value. Usually the free air correction and the Bouguer correction are combined. They oppose each other and their combination is

$$(\delta g)_F + (\delta g) = (0.3086 - 0.0419\rho)h \text{ mGal}$$

This correction shows the required accuracy of the topographic elevation determination. An error of 10cm with p=2.67g/cm3 corresponds to an error in the reduced gravity of 0.02 mgal, which is about the accuracy of a modern gravimeter. According to the above facts reduction is applied to the present data compilation. The elevations determined for all the gravity points are reported (EIGS) to have an error ranging from 5 to 10m.

4.2.3 The topographic or terrain correction

This correction, as mentioned before, is required to eliminate the effects of topography, i.e., the effects of excess of rock above the level of a point and deficiency of rock below that level. The mass deficiency can be considered as negative mass, the terrain correction therefore will always be positive. In other words both mountains and valleys reduce the observed gravity. The observed gravity in flat terrain will therefore always be larger than for any other topographic configuration. This may produce fake anomalies.

The simple Bouguer anomaly is calculated according to the formula

$$\Delta g_B = g - \gamma + (0.3086 - 0.0419\rho)h$$

CHAPTER FIVE

5. Compilation of Gravity Data and interpretation of Anomaly maps.

A total of 1800 point gravity data have been used in this compilation. The gravity data are obtained from two gravity data sources:

1. The Ethiopian Institute of Geological Survey (present data set)
2. Dr. Abera Alemu (Geophysical Observatory)

The point gravity values are reduced to the same datum (IGSN 1971) and Geodetic reference System 1967 (Moritz, 1971) using FORTRAN program developed by Dr. Abera. During compilation, based on an evaluation of standardizing gravity data on a global scale, some of the original data from EIGS were converted to a new value by incorporating a difference of 14.91 mGals. This difference was obtained upon comparison of the EIGS and Dr. Abera's data with the same location and elevation. The change of datum value is safe with an average error of 0.02 mGal on the observed gravity.

All the data acquired by Dr. Abera are reported to have previously been converted into IGSN-71 values. Except the slight discrepancies of values of gravity which could arise due to measurement of latitude of gravity stations, measurement of height above sea level, datum value and gravity calibration standard; all gravity data, which are used in this compilation, has been unified and they have the same range of accuracy.

To avoid ambiguity, all the digitized data from map are discarded, since they do not give the expected anomaly trend in the gravity anomaly map compiled here.

5.1 The Bouguer and Free Air Anomaly Maps

The Bouguer gravity anomaly map (Fig. 8) is highly influenced by deep rocks that reflect the effect of regional features.

The Bouguer gravity anomaly pattern in the study area generally follow the structural trend of the individual rift segments where they generally show a NWN - SES orientation corresponding to the southern Ethiopian rifts and NEN - SWS orientation corresponding the southern end of the Main Ethiopian Rift.

The Bouguer gravity anomaly map also reveals that the southern rifts are associated with relative positive while the Main Ethiopian Rift is associated with relative negative gravity anomaly. The zone dividing the Main Ethiopian rift from the Southern Ethiopian rift exhibit Bouguer values intermediate between the values corresponding between the two rift segments and the structure that is oriented in E - W direction following the orientation of the Konso uplift and neighboring uplifted regions.

A pronounced Bouguer gravity minima of -260 mGal occur north east of Lake Abaya. This seems to correlate with the highest point of the eastern escarpment at $6^{0}50'$ latitude and $39^{0}E$ longitude which forms the south western end of the Arsi - Bale Range.

The western shoulder of the Chew Bahir rift defined by relatively high amplitude Bouguer gravity maxima of -65 to -80 mGal which is associated with the Hammar horst is oriented in NNW - SSE direction. The map also shows a sharp fall in the Bouguer gravity values along the eastern and western margin of the Chew Bahir rift looking to be rapidly replaced by relatively low gravity anomaly values at the center of the Chew Bahir Rift Floor. This sudden change in the gravity amplitude seems to correlate with the presence of a series of fault systems at the flanks of the Chew Bahir Rift marking its western margin.

Similarly the eastern shoulder of the Chew Bahir rift, Konso uplift, with relative positive gravity anomaly of -100 mGal is oriented in NNW - SSE direction. But the anomaly magnitude decreases in an east ward direction towards Yabelo along latitude 4.75^{0} N.

A relative positive anomaly with -80 mGal associated with the uplifted regions bounding the

Chew Bahir rift in the south is oriented in E - W direction.

The Chew Bahir rift floor is associated with negative Bouguer anomaly of magnitude -120 to -140 mGals oriented along the rift axis in N - S direction.

The relative positive gravity anomaly over the Main Ethiopian rift floor along the Lake Chamo and Lake Abaya is oriented in the NNE - SSW direction.

Northeast of Konso; the low Bouguer anomaly with -140 to -200 mGal possibly correlates with the southern end of the Main Ethiopian Rift System. It appears that there is an offset of gravity anomaly trends at the Omo and Chew Bahir rift with that of the southern end of the Main Ethiopian Rift System. The cause of the offset is of course controversial; according to the works of Tesema (1996), Asfaw (1990) and Tiercelin (1988), it appears that NW-SE trending transcurrent faults could be possible cause of rift offset.

The gravity minima which coincide with the strike of the Chew Bahir rift is small in amplitude and interpretation of refraction seismic profile along north Turkana rift revealed 3.0 km thick sediment existed beneath the Turkana Group basalt (KRISP, 1989). This could be attributed to the minimam gravity anomaly values in the Chew Bahir rift floor.

The concordance relation ship suggests that the sedimentary fill in the basin is largely influenced by the underlying volcanic rocks of density comparable to that of the basement. Most of the eastern part of the survey has scarce gravity data, this implies that the computer software uses extrapolation in this region. It is unrealistic to give interpretational comment in this region.

The free air gravity anomaly is closely related to the topographic relief (Fig.9). The uplifted blocks and depressions are characterized by high and low free air gravity anomalies respectively.

The uplifed regions of the Chancha horst on the west and the Amaro horst on the east bounding the MER considered under this study are marked by positive free air anomalies while the rift floor in between them is a site of negative free air anomaly.

Further south in the SER the uplifted regions, the Hammar horst on the west and the Teltele uplands on the east bounding the Chew Bahir rift are both markerd by positive free air anomalies while the corresponding rift floor is marked by a negative free air anomaly. Moreover, the uplifted region south of the Chew Bahir rift is also a site of positive free air anomaly.

The southern rifts are defined by free air minima of -40 to -75 mGal. The transition from rift to the plateaus or the horsts is marked by gravity gradient (between 0 to 40 mGal). This indicates that the border of the Omo and Chew Bahir rifts are affected by subsidence (Tessema, 1996).

The Turkana rift north of Kenya, and its extension north wards into the rifted regions in Ethiopia that all lie west of the Hammar range and associated with a negative free air anomaly.

With the exception of the E - W oriented Konso upland that separates the MER from the SER at about latitude $5^0 50'$ all the uplifted regions bounding the rifts in the MER and SER are generally associated with a positive free air anomaly while the corresponding rifted regions are marked by a negative free air anomaly.

This phenomena is a character that is exhibited by all segments of the rift zones in east Africa (Afar, Kenyan rift) (Alemu, 1992).

There is also a strong correlation of the free air anomalies in both the SER and the MER in delineating the structures (horsts and grabens) associated with them in a similar way.

This signature of the free air anomaly field thus shows that, there is a continuity of the MER down to the SER being displaced to the west at the Konso upland.

Comparison of free air and Bouguer anomaly fields in the SER and MER show that:

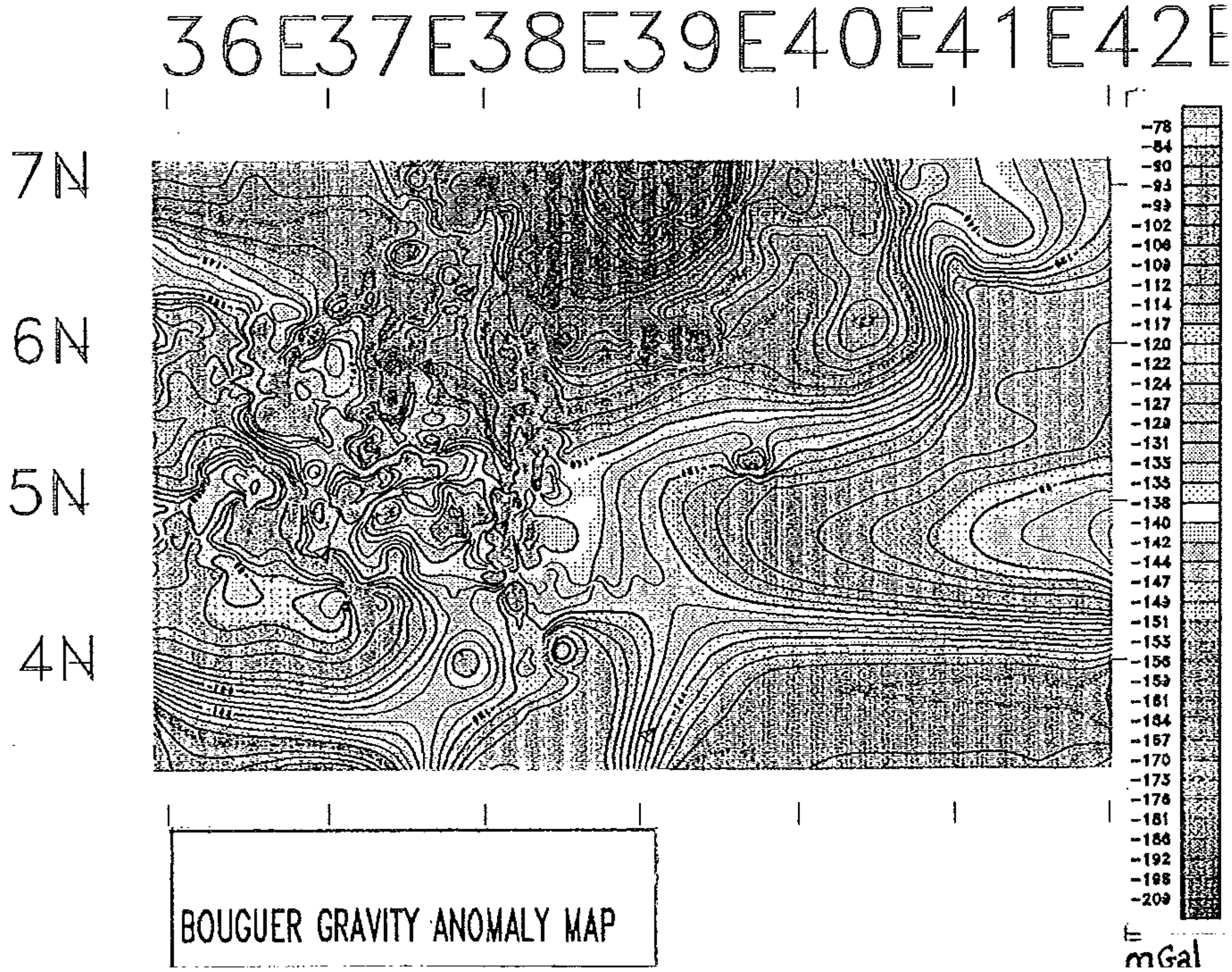
1. Association of positive Bouguer gravity anomaly on the rift floor and negative Bouguer gravity anomaly on the uplifted regions of the MER is observed.

2. Association of negative Bouguer gravity on the Chew Bahir rift and positive anomaly on the margins of the SER is observed.

This association of the Bouguer anomaly field on the two rift systems show that there is an inverse correlation in the Bouguer field between the two rift systems.

On the free air anomaly map rift zones correspond to negative anomaly and uplifts are associated to relative positive anomalies for both rift systems, indicating that there is a direct relationship in the free air anomaly field.

The Bouguer and free air anomaly fields observed in the MER have the general character of both fields in rift zones as is the case in East Africa, where as the Bouguer anomaly observed in the SER is distinctly different from the Bouguer anomaly observed in east Africa (Kenyan rift, Afar).



BOUGUER GRAVITY ANOMALY MAP

Free Air Anomaly Map

5.2 The Residual and Regional Anomaly separation

The terminology of "regional" and "residual" used in this text is, the regional anomaly is the broad anomaly characterized by long wave length and low amplitudes of Bouguer gravity anomalies of large dimensional crustal features. The depth of the cause of these anomalies is usually great and possibly comparable with depth limit of crust and upper mantle interface. As a result of this, the anomaly become more spread out in wave length and its amplitude decreases. The smoothness (or apparent wave length) of anomalies is roughly proportional to the depth of the lateral density changes. The horizontal extent of an anomaly is therefore usually a measure of the depth of the anomalous mass. The residual anomalies are associated with short wave length and relatively high amplitudes of Bouguer gravity anomalies which are due to the cause of anomalies located at shallow depth.

There are some circumstances, however, in which smoothing method cannot be used.

1. When the ground is very hilly and the surface materials are inhomogeneous, the Bouguer density is likely to vary. Under these conditions the residual anomalies in the primary Bouguer map are likely to be due to topography rather than to subsurface structures.
2. If the regional trend is very strong, residual anomalies are easily missed by visual methods.
3. When residual anomalies are very large, the regional trends are often difficult to discern. This is particularly true in very large scale surveys, although it is important only if the regional gravity map itself is required.

In this survey separation of Residual and Regional gravity grided values were accomplished using a computer software which uses the trend surface analysis to produce regional anomaly. The regional gravity anomaly is then subtracted from the Bouguer anomaly to produce residual gravity anomaly map.(appedix 1)

5.3 The Residual Gravity Anomaly Map

Removing the long wave length anomaly from the observed gravity field the remaining gravity anomaly is known as the residual anomaly (Fig. 10). The residual anomalies may provide the direct evidence for reservoir-type structures or mineral ore bodies. To be interpreted, these anomalies must somehow be removed from the regional background. These presumably is the " geological residue" of the total gravity picture. Accordingly, it constitutes the basic material for geological interpretation.

Since the removed regional anomaly is very deep, it gives the structural feature within a wide range of depths clearly. Actually it is not easy to find depth relations between gravity anomaly and geologic map since a geological map is mainly drawn in terms of surface geology.

The residual anomaly map is used here to relate structural features (e.g. faults), subsurface geology and hidden structures at more or less shallow depth, even when they can not be detected by Bouguer gravity anomaly map. In this survey the residual anomaly map is analyzed for specific areas of interest (the anomalous areas) to identify at least lateral limits related to the rock type, interpreted in a broad sense for preliminary purposes.

As is already said, what is hidden in the Bouguer gravity anomaly map is visible in the residual anomaly map, since the grided regional values for deep structural features were subtracted from grided Bouguer values.

This anomaly map (residual) is in good agreement with the geology of the study area. Within the rift most of the subsurface rocks are Quaternary undifferentiated lacustrine deposits.

The other anomaly patterns depicted on the residual anomaly map are correlated to their respective geologic structures (fig.3) as follows:

- the maxima of a circular trend (23 mGal) is related to granite and quartz diorite (lower pleozoic and precambirian) and high grade metamorphic rocks and precambrian (upper pretorozoic).

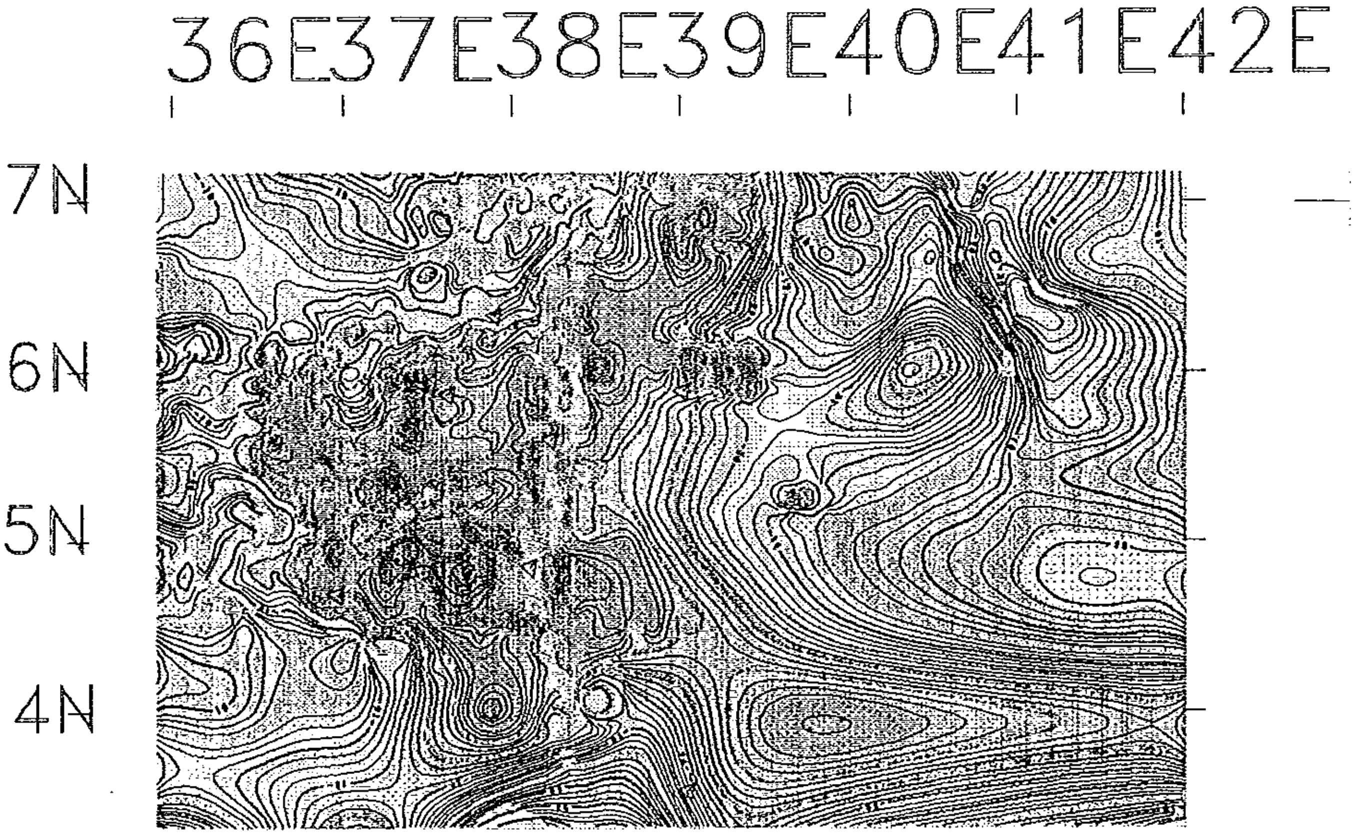
- the anomaly with relative maxima (0 to 20 mGal) south of Mega can be related to the presence of precambrian rocks.

- the relative minimum with -20 to -35 mGal at 6^0 N east of Kibre Mengist and north east of Negele, as shown in the contour elongated NE-SW, is bordered by NNE - SSW parallel fault which can be observed in the geological map. The center of this contour can be related to Archean rocks of the Alaghe group and the surrounding is Jurassic. The NNE - SSW trending faults are crossed by NNW - SSW fault lines on the east and form circular trends.

- the relative maxima (20 to 35 mGal) observed in the north eastern corner of the survey area, which is elongated NW - SE, including Gasera and Ginir, is related to two parallel NNW - SSE trending fault on both sides.

The sharp fall of the eastern margin of the rift and bending of contour lines at Negele to the east, best fits with the trend of the fault. The anomaly observed at Negele (0 to -15 mGal) and in the surrounding area is correlated to isciabiadoa formation (Early - Late).

East of Yabelo the residual gravity maxima define the uplifted terrain which can be related to NNW - SSE trending faults, they are associated with local effects of denser rocks that are situated at shallow depth.



Residual Anomaly Map

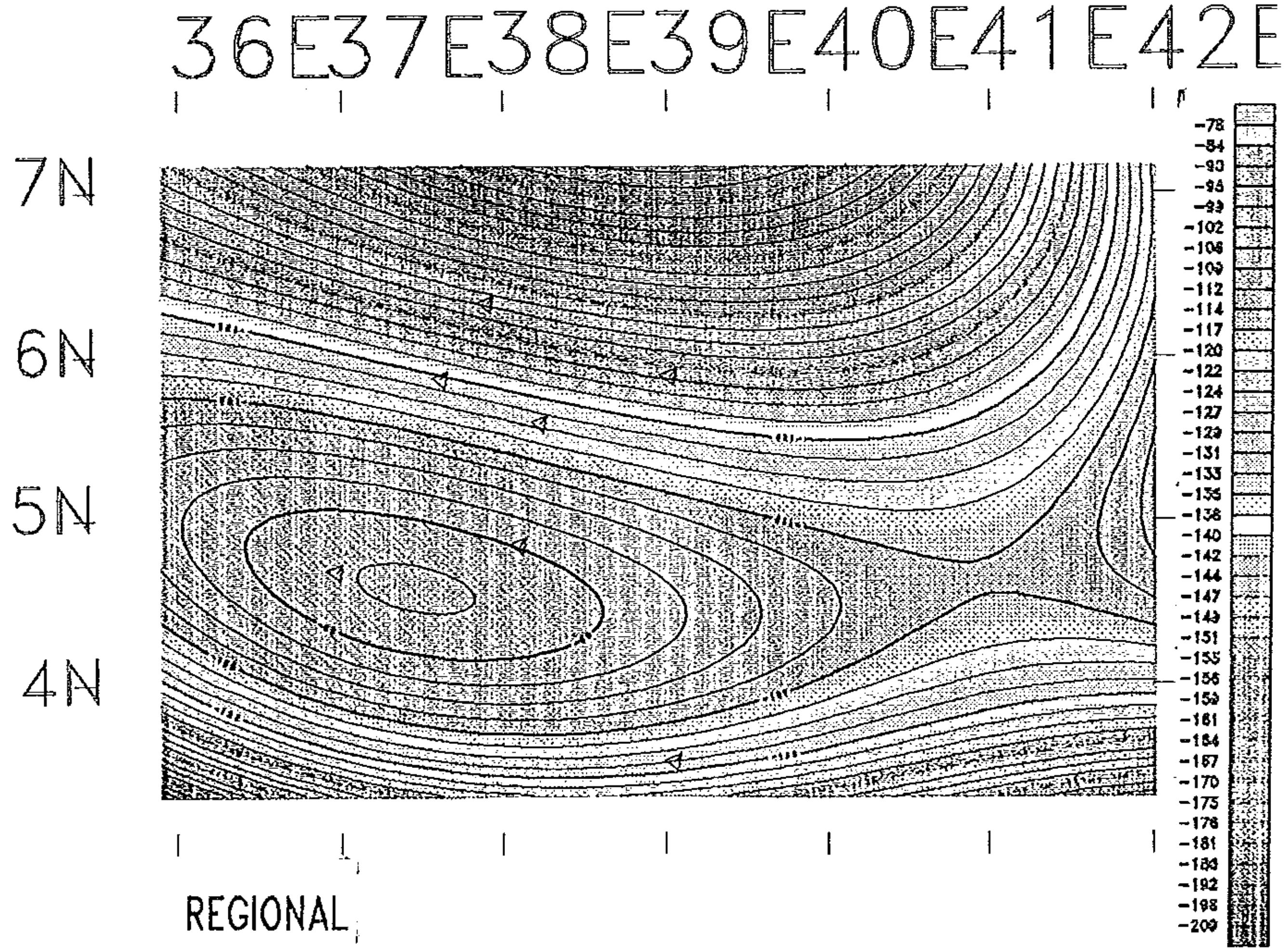
5.4 The Regional Anomaly Map

The regional gravity map of the area revealed interesting relations with the broad structural features of the region. The inverse relation ship between the topography of north and north western sides of the region and the regional gravity field also indicate that the topographic relief is isostaticaly compensated by low density material at depth (Makris et al, 1975). The NW - SE trending gravity maxima is associated with the stretching of the lithosphere which is the undergoing process. The magnitude of the gravity maxima in this zone increases to the west which is the culmination of high amplitude of regional gravity field in the area (Tessema, 1996). Under this study the culmination of the regional gravity maxima occurs at about latitude $4^{0}45'$N and longitude $37^{0}30'$E which lies about the location of Chew Bahir rift and is thought to be the highly thinned part of the crust in this zone of the rift segment.

The regional anomaly map shows the transition form negative to positive gravity field from MER to SER and from positive to negative towards the Kenyan rift, which is clearly manifested in the Bouguer anomaly map. This could be related to the distinction between the SER and the other two rift systems (MER and Kenyan rifts).

The deep structural features of the region revealed by the regional gravity field over the SER indicate that crustal thinning beneath the SER is due to the upcoming of the anomalous mantle material to higher levels of the crust.

The E-W elongated positive gravity field over the SER could be due to the deep structural features of the rift zone indicating the extension of the rift in an E-W direction perpendicular to the rift axis.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REGIONAL
mGal

CONCLUSION

·The axial relative positive anomaly observed on the Bouguer anomaly map of the MER and the Kenyan rift is not evident in the SER.

· The rift zone in the southern Ethiopian rifts consists descrete grabens and half grabens oriented in NNW - SSE direction in which case their axis of orientation does not coincide with the general axis of the main Ethiopian rift.

· Contrary to that observed in the MER, a negative anomaly is observed beneath the floor of each of the discrete rifts (grabens) in the SER.

·The Chew Bahir rift is a major rift zone flanked by the Hammar horst on the west and Teltele horst on the east.

· The horsts are associated with relative positive anomaly while the rift floor is a site of negative anomaly.

The gravity maps compiled under this study indicate the following results:

1. On the Bouguer anomaly map the anomaly magnitudes observed in the SER are higher than those observed on the MER and Kenyan rifts, the maximum anomaly (-70 to -80 mGal) in the SER, (-160 to -165 mGal) in the MER (-55 to -65 mGal) in the Turkana rift and (-165 to -170 mGal) in the Kenyan rift.

2. On the regional anomaly map a positive anomaly is observed on the SER while negative anomaly on both the MER and the Kenyan rifts.

·The results of this study and previous studies of the gravity field of the East African rift zones, thus indicate that the SER is a zone of positive anomaly.

·In terms of gravity anomaly positiveness, the SER may be thought to be:

more matured than the MER and the Kenyan rifts or

a zone of high density intrusives 0r

a zone where the anomalous mantle exists at shallow depth. Which ever of these inferences should be confirmed by other geophysical evidences.

RECOMMENDATION

·The gravity anomalies in this study are computed by assuming the mean crustal density (2.67g/cm3). To correlate (interprete) the different anomalies observed in the gravity maps with surface or subsurface geology of the region, density determination of the rocks in the region is highly imperative.

·Much more gravity observations are needed for a detailed study of the region for economic or structural evaluation.

Other geological and geophysical investigations, like seismic, should be carried out in the region to constrain and/or supplement the gravity data for modeling the structure of the crust beneath the rift (SER).

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Appedix 1

The Residual and Regional Anomaly separation

GRIDHANN

The Hanning filter is a smoothing filter defined by the following 3x3 point Kernel filter

0.06	0.10	0.06
0.10	0.36	0.10
0.06	0.10	0.06

Smoothing has been applied three times to smooth noise before contouring.

Coefficient for Hanning window are motivated by a gradual rather than an abrupt truncation of the fourier coefficients.

Von Hann Window is given by:

$$W_i = \tfrac{1}{2} + \tfrac{1}{2}\cos(\pi i/m+1) \quad \text{for } i \le m$$

$$0, \quad \text{otherwise}$$

GRIDTRND removes a trend surface from a grid

It can be useful for removing regional trends and gradients. It is also a fast way to remove a strong gradient, such as an approximation to an IGRF.

-t=a1,a2,a3,...defines the coefficient of the polynomial to remove as follows:

a1 + a2*X + a3*Y + a4*X*X + a5*X*Y + a6*Y*Y + a7*X*X*X + a8*X*X*Y + a9*X*Y*Y + a10*Y*Y*Y

Appendix 2

GRAVITY DATA IN STANDARD FORMAT
BETWEEN 3.3-7.15 N AND 36-42 E

STATN Nr	LATIT (DEG)	LONG (DEG)	ELEV (MET)	G(Obs) (MGAL)
1	7.1300	38.3700	1880.00	977521.4
2	7.0900	38.3200	1755.00	977560.6
3	7.0600	38.2900	1686.00	977570.8
4	7.0600	38.2800	1680.00	977570.6
5	7.0800	38.2700	1680.00	977573.4
6	7.0800	38.2600	1680.00	977575.4
7	7.0800	38.2600	1680.00	977583.2
8	7.0700	38.2600	1680.00	977584.4
9	7.0500	38.2600	1680.00	977574.4
10	7.0300	38.2800	1680.00	977564.9
11	7.0700	38.2700	1682.00	977564.2
12	7.0300	38.2800	1685.00	977564.2
13	7.0200	38.2800	1815.00	977531.6
14	7.0300	38.2900	1690.00	977563.7
15	7.0900	38.3100	1747.00	977562.4
16	7.0100	38.2900	1738.00	977546.4
17	7.1200	38.3600	1888.00	977523.6
18	7.1200	38.2800	1800.00	977563.6
19	7.1500	38.3100	1745.00	977569.2
20	7.1300	38.0400	1790.00	977566.1
21	7.0900	38.0300	1930.00	977539.8
22	7.0000	38.3000	1705.00	977552.4
23	7.1300	38.3600	1880.00	977522.2
24	7.1000	38.4000	2080.00	977477.2
25	7.0900	38.4100	2275.00	977437.4
26	7.0600	38.4500	2560.00	977365.4
27	7.0500	38.4600	2650.00	977344.2
28	7.1200	38.3600	1930.00	977523.6
29	7.1200	38.2800	1880.00	977563.6
30	7.1500	38.3100	1780.00	977569.2
31	7.1300	38.0400	1780.00	977566.1
32	7.0900	38.0300	1915.00	977539.8
33	7.0000	38.3000	1705.00	977552.4
34	7.1300	38.3600	1920.00	977521.4
35	7.1000	38.4000	2080.00	977477.2
36	7.0900	38.4100	2325.00	977430.6
37	7.0600	38.4500	2560.00	977365.4
38	7.0500	38.4600	2655.00	977345.6
39	7.0300	38.2800	1685.00	977565.1
40	7.0000	39.2700	1682.00	977565.2
41	7.0900	37.5800	1935.00	977533.8
42	7.0400	37.5600	1840.00	977551.7
43	7.0900	37.5800	1960.00	977533.8
44	7.0400	37.5600	1870.00	977551.7

45	7.0300	37.2700	1810.00	977588.4
46	6.5900	37.5300	1965.00	977520.4
47	6.5600	37.5000	2175.00	977482.9
48	6.5200	37.4500	2035.00	977518.9
49	6.5100	37.4900	1810.00	977558.4
50	6.4800	37.5300	1605.00	977615.1
51	6.4500	37.5500	1410.00	977652.9
52	6.3900	37.5700	1315.00	977677.2
53	6.3600	37.5400	1265.00	977690.4
54	6.3200	37.5200	1275.00	977679.2
55	6.2800	37.4900	1360.00	977664.4
56	6.2300	37.4900	1280.00	977684.9
57	6.1800	37.4900	1365.00	977661.6
58	6.1400	37.4800	1255.00	977674.9
59	6.0900	37.4500	1255.00	977680.9
60	6.0600	37.4200	1255.00	977670.7
61	6.0400	37.3800	1300.00	977673.3
62	6.0300	37.3700	1425.00	977634.1
63	6.5900	37.5300	2000.00	977520.4
64	7.1404	38.3444	1883.00	977537.6
65	7.1452	38.3348	1856.00	977544.2
66	7.1482	38.3246	1816.00	977552.9
67	7.1224	38.3720	2018.00	977499.9
68	7.1140	38.3996	2178.00	977465.1
69	7.1008	38.4266	2368.00	977416.7
70	7.0780	38.4440	2520.00	977379.8
71	7.0558	38.4692	2653.00	977347.2
72	7.1500	38.3804	1976.00	977510.1
73	7.1392	38.3708	1947.00	977518.4
74	7.1404	38.4374	2230.00	977451.7
75	7.1404	38.4404	2261.00	977446.9
76	7.1200	38.3882	2078.00	977487.4
77	7.1032	38.4104	2303.00	977437.6
78	7.0882	38.4350	2450.00	977398.2
79	7.0654	38.4584	2572.00	977363.1
80	7.0468	38.4848	2678.00	977338.7
81	7.0456	38.2262	2065.00	977493.8
82	7.0084	38.1944	2112.00	977493.4
83	7.0132	38.4200	1666.00	977588.1
84	7.0120	38.4008	1683.00	977582.7
85	7.0114	38.3798	1719.00	977572.9
86	7.0096	38.3600	1773.00	977563.8
87	7.0144	38.3426	1823.00	977548.3
88	7.0204	38.3270	1875.00	977544.4
89	7.0210	38.3168	1816.00	977555.4
90	7.0330	38.3036	1840.00	977555.7
91	7.0384	38.2838	1840.00	977548.7
92	7.0432	38.2652	1851.00	977542.7
93	7.0612	38.2646	1953.00	977526.4

94	7.0060	38.4272	1649.00	977597.4
95	7.0690	38.2304	2069.00	977491.6
96	7.0312	38.2106	2116.00	977485.8
97	7.0126	38.4550	1675.00	977583.9
98	7.0114	38.3900	1703.00	977577.3
99	7.0108	38.3702	1752.00	977567.4
100	7.0126	38.3528	1804.00	977557.2
101	7.0198	38.3354	1875.00	977543.2
102	7.0174	38.3234	1879.00	977544.1
103	7.0252	38.3066	1830.00	977553.9
104	7.0354	38.2940	1839.00	977551.3
105	7.0390	38.2730	1847.00	977544.1
106	7.0522	38.2646	1859.00	977545.3
107	7.0858	38.4920	1658.00	977583.3
108	7.0200	37.5400	1884.00	977541.4
109	7.0300	37.5600	1883.00	977540.2
110	7.0600	37.5700	1890.00	977543.4
111	7.1000	37.5900	1952.00	977531.8
112	4.5600	38.0000	1570.00	977614.9
113	4.5500	38.0200	1765.00	977570.1
114	4.5300	38.0600	1770.00	977567.9
115	4.5400	38.1100	1610.00	977600.7
116	4.5800	38.1200	1545.00	977615.9
117	4.5700	37.5500	1270.00	977682.4
118	4.5600	37.5800	1480.00	977636.4
119	5.0300	38.1200	1670.00	977587.6
120	5.0800	38.1200	1665.00	977587.4
121	5.1300	38.1300	1615.00	977599.7
122	5.1700	38.1500	1595.00	977610.8
123	5.2200	38.1700	1610.00	977603.3
124	5.2600	38.1700	1690.00	977577.3
125	5.2700	38.1700	1710.00	977572.2
126	5.3100	38.1600	1935.00	977525.9
127	5.3400	38.1500	1935.00	977528.4
128	5.3800	38.1500	1895.00	977534.7
129	5.4200	38.1300	1700.00	977580.4
130	5.4300	38.1200	1980.00	977519.9
131	5.4500	38.1200	2225.00	977460.9
132	5.4700	38.1200	2040.00	977500.4
133	5.5300	38.1300	1690.00	977569.9
134	5.5800	38.1200	1690.00	977571.9
135	5.5900	37.3500	1185.00	977676.4
136	5.5600	37.3300	1205.00	977679.9
137	5.5100	37.3200	1185.00	977687.6
138	5.4600	37.3000	1255.00	977679.6
139	5.4200	37.2900	1460.00	977635.7
140	5.4100	37.2800	1560.00	977613.4
141	5.3300	37.2600	1835.00	977562.8
142	5.3100	37.2700	1600.00	977615.3

143	5.2700	37.2800	1340.00	977675.9
144	5.2200	37.3100	1280.00	977701.4
145	5.1800	37.3400	1370.00	977703.2
146	5.1600	37.3300	1495.00	977669.8
147	5.1300	37.3400	1285.00	977709.4
148	5.1100	37.3500	980.00	977773.9
149	5.0900	37.3900	910.00	977777.4
150	5.0700	37.4300	925.00	977757.2
151	5.0500	37.4600	940.00	977745.7
152	5.0200	37.4900	1020.00	977728.4
153	5.0000	37.5200	1115.00	977713.6
154	6.5900	37.5300	2000.00	977520.4
155	6.5700	38.2800	1865.00	977524.4
156	6.5400	38.2500	1885.00	977518.3
157	6.5000	38.2200	1800.00	977541.1
158	6.4600	38.2000	1725.00	977555.6
159	6.4200	38.2000	1805.00	977536.3
160	6.3800	38.2100	1785.00	977535.6
161	6.3700	38.2200	1780.00	977518.7
162	6.3700	38.2500	2000.00	977491.4
163	6.3700	38.2600	2180.00	977453.8
164	6.3600	38.2700	2370.00	977412.6
165	6.3200	38.2800	2695.00	977347.6
166	6.3100	38.3000	2745.00	977332.9
167	6.3000	38.3100	2740.00	977336.9
168	6.0800	36.5400	1092.00	977715.9
169	6.1300	36.5600	1130.00	977710.4
170	6.1500	36.5900	1166.00	977703.9
171	6.1700	37.0100	1253.00	977682.2
172	6.2100	37.0300	1235.00	977681.3
173	6.2500	37.0800	1116.00	977707.2
174	6.2700	37.1100	1063.00	977717.7
175	6.2800	37.1200	1067.00	977724.8
176	6.2900	37.1400	999.00	977737.3
177	6.5200	37.4600	2069.00	977514.1
178	6.5700	37.5100	2160.00	977486.2
179	6.5800	37.5300	2009.00	977511.6
180	6.5300	37.4800	2211.00	977481.3
181	6.2800	37.1900	1034.00	977727.6
182	6.2800	37.2200	1207.00	977692.2
183	6.2900	37.2400	1332.00	977666.4
184	6.2900	37.2500	1409.00	977646.3
185	6.3000	37.2600	1431.00	977640.9
186	6.3000	37.2700	1643.00	977602.1
187	7.0800	38.0200	2013.00	977520.6
188	7.1200	38.0400	1885.00	977551.6
189	7.1500	38.0500	1783.00	977564.9
190	7.1500	38.1100	1827.00	977552.4
191	7.1400	38.3100	1749.00	977577.3

192	7.1300	38.3400	1817.00	977549.8
193	7.1200	38.3500	1928.00	977525.3
194	7.1300	38.3600	1880.00	977521.9
195	7.1500	38.3600	1949.00	977516.6
196	7.1300	38.3700	1880.00	977521.4
197	7.0900	38.3200	1755.00	977560.6
198	7.0600	38.2900	1686.00	977570.8
199	7.0600	38.2800	1680.00	977570.6
200	7.0800	38.2700	1680.00	977573.4
201	7.0800	38.2600	1680.00	977575.4
202	7.0800	38.2600	1680.00	977583.2
203	7.0700	38.2600	1680.00	977584.4
204	7.0500	38.2600	1680.00	977574.4
205	7.0300	38.2800	1680.00	977564.9
206	7.0300	38.2800	1685.00	977564.2
207	7.0200	38.2800	1815.00	977531.6
208	7.0300	38.2900	1690.00	977563.7
209	7.0900	38.3100	1748.00	977562.4
210	7.0100	38.2900	1738.00	977546.4
211	7.0300	37.5600	1883.00	977540.2
212	7.0953	38.7960	2678.00	977339.3
213	7.1195	38.8076	2662.00	977339.4
214	7.1347	38.8324	2665.00	977337.6
215	6.7383	39.2147	2470.00	977398.9
216	7.1281	37.9523	1950.00	977531.4
217	7.1009	37.9476	1913.00	977537.4
218	7.0772	37.9436	1869.00	977543.1
219	7.0480	37.9269	1845.00	977550.7
220	7.0144	37.8946	1888.00	977540.7
221	6.9886	37.8784	1930.00	977529.4
222	6.9378	37.8398	2084.00	977499.4
223	6.9070	37.8181	2211.00	977476.3
224	6.8875	37.8012	2209.00	977480.9
225	7.1384	38.1080	1760.00	977565.6
226	7.0880	38.1554	1710.00	977564.3
227	7.0081	37.7294	1845.00	977546.6
228	7.0614	37.7098	1745.00	977558.9
229	7.1051	37.7147	1715.00	977573.9
230	7.1439	37.7026	1662.00	977593.2
231	7.0649	37.6763	1780.00	977574.9
232	7.1074	37.6621	1716.00	977592.2
233	7.1282	37.6413	1658.00	977606.7
234	7.1355	37.5810	1540.00	977635.7
235	7.0108	38.1137	1500.00	977608.4
236	7.0223	38.2336	1800.00	977542.1
237	7.1421	38.1664	1780.00	977558.4
238	7.1189	37.9120	1896.00	977537.4
239	7.1435	37.7951	1905.00	977539.1
240	7.0827	38.6351	1860.00	977529.9

241	7.1268	38.5359	1710.00	977562.9
242	7.1046	38.5721	1700.00	977568.9
243	7.1075	38.5094	1698.00	977564.4
244	7.0795	38.5088	1745.00	977551.1
245	7.0840	38.9629	2738.00	977310.2
246	7.0851	38.9101	2652.00	977336.3
247	7.0349	39.1582	2375.00	977381.2
248	7.0756	39.1784	2378.00	977483.4
249	7.1089	39.1961	2355.00	977388.4
250	7.1240	39.1549	2450.00	977372.2
251	7.0861	39.0598	2590.00	977339.6
252	7.0467	39.0428	2471.00	977369.9
253	7.1186	38.9103	2636.00	977328.8
254	7.0089	38.4887	2019.00	977480.2
255	7.0364	38.4672	1820.00	977531.6
256	7.0034	38.4527	1788.00	977538.6
257	6.9834	38.4310	1705.00	977562.4
258	6.9294	38.4698	1909.00	977519.3
259	6.9024	38.4365	1910.00	977516.7
260	6.8758	38.4076	1840.00	977532.2
261	6.8452	38.3850	1808.00	977542.4
262	6.8009	38.3810	1769.00	977548.4
263	6.7547	38.3756	1675.00	977567.6
264	6.9261	38.3618	2002.00	977506.9
265	6.9609	38.3127	1850.00	977533.9
266	6.9400	38.2505	1870.00	977534.9
267	6.9080	38.3137	1874.00	977537.2
268	6.8462	38.2977	1910.00	977521.7
269	6.8052	38.2801	1873.00	977534.7
270	6.7659	38.2840	1795.00	977554.9
271	6.8682	38.4470	1870.00	977519.1
272	6.8267	38.4314	1841.00	977527.3
273	6.7726	38.4349	1735.00	977547.9
274	6.8322	38.4683	1830.00	977525.9
275	6.8056	38.4744	1840.00	977518.4
276	6.9416	37.9244	1865.00	977532.9
277	6.9501	37.9703	1778.00	977556.9
278	6.9271	37.8857	1910.00	977527.9
279	6.8949	37.8675	2058.00	977503.6
280	6.9050	37.9052	1876.00	977533.4
281	6.8734	37.9372	1592.00	977593.2
282	6.8798	37.9913	1458.00	977628.9
283	6.8731	38.0393	1430.00	977645.8
284	6.8820	38.0786	1438.00	977636.2
285	6.8357	37.9027	1738.00	977567.4
286	6.8754	37.8259	2130.00	977483.7
287	6.8394	37.8222	1854.00	977519.2
288	6.8097	37.8062	1862.00	977541.3
289	6.7847	37.8413	1860.00	977533.4

290	6.7629	37.8750	1806.00	977563.4
291	6.8529	37.7108	1886.00	977552.4
292	6.8931	37.6908	1965.00	977532.2
293	6.9224	37.6500	2065.00	977515.6
294	6.9603	37.6820	1985.00	977529.8
295	6.8434	37.6927	1878.00	977557.7
296	6.8356	37.6683	1858.00	977565.4
297	6.8298	37.6195	1860.00	977574.4
298	6.8362	37.5625	1880.00	977571.4
299	6.8481	37.7611	1976.00	977537.4
300	6.7888	37.7528	1818.00	977561.6
301	6.7493	37.7719	1800.00	977561.4
302	6.8815	37.6479	2062.00	977522.6
303	6.9024	37.6111	1740.00	977594.7
304	6.9198	37.5373	1245.00	977693.2
305	6.9061	37.4349	705.00	977792.9
306	6.8912	37.7263	1918.00	977545.9
307	6.9289	37.7274	1932.00	977534.4
308	6.7768	37.5918	1680.00	977606.8
309	6.7843	37.5339	2063.00	977532.9
310	6.7853	37.4744	2510.00	977443.6
311	6.7607	37.4361	2310.00	977488.2
312	6.7384	37.3873	1950.00	977562.9
313	6.8505	37.7466	1940.00	977542.1
314	6.8072	37.6976	1856.00	977556.3
315	6.7531	37.6661	1763.00	977580.7
316	6.7251	37.6304	1735.00	977594.4
317	6.7112	37.5766	1610.00	977620.2
318	6.6734	37.5727	1340.00	977671.4
319	6.6227	37.5681	1200.00	977690.1
320	6.5652	37.5472	1258.00	977676.1
321	6.5317	37.5240	1277.00	977672.7
322	6.6553	37.7249	1790.00	977579.9
323	6.5243	37.7854	1211.00	977694.7
324	6.4840	37.7620	1192.00	977688.4
325	6.4477	37.7456	1238.00	977675.4
326	6.6432	37.8495	1318.00	977668.9
327	6.6265	37.8647	1302.00	977673.1
328	6.6231	37.8862	1300.00	977672.7
329	6.7990	38.0799	1330.00	977667.4
330	6.8352	38.0970	1362.00	977653.1
331	6.8850	38.1157	1442.00	977626.4
332	6.9296	38.1301	1476.00	977620.7
333	6.7631	37.7997	1745.00	977574.4
334	6.4003	37.7482	1255.00	977674.9
335	6.3537	37.7526	1297.00	977671.6
336	6.3116	37.7660	1280.00	977673.7
337	6.2433	37.7442	1200.00	977680.9
338	6.2109	37.7161	1320.00	977657.4

339	6.2796	37.7832	1197.00	977685.9
340	6.7487	38.4331	1780.00	977537.9
341	6.7489	38.4675	1845.00	977516.7
342	6.6967	38.4574	1880.00	977515.1
343	6.6578	38.4463	1858.00	977521.2
344	6.7084	38.4092	1812.00	977529.2
345	6.7477	38.3879	1740.00	977550.4
346	6.6952	38.3592	1836.00	977530.8
347	6.6586	38.3954	1820.00	977529.9
348	6.6290	38.4138	1885.00	977517.2
349	6.5964	38.4203	1898.00	977516.8
350	6.5738	38.4455	2263.00	977434.9
351	6.5822	38.4826	2516.00	977383.9
352	6.5277	38.4894	2728.00	977339.2
353	6.4807	38.5345	1799.00	977538.7
354	6.4491	38.3249	1800.00	977536.9
355	6.4203	38.3157	1566.00	977591.2
356	6.4987	38.3918	1860.00	977524.7
357	6.5297	38.4252	1965.00	977497.6
358	6.5614	38.4263	2155.00	977458.8
359	6.5668	38.3944	1920.00	977510.3
360	6.5326	38.3818	1920.00	977512.2
361	6.4511	38.3733	2025.00	977520.9
362	6.4425	38.3514	1925.00	977509.9
363	6.3634	38.3458	2140.00	977521.1
364	6.3161	38.3595	2320.00	977427.9
365	6.3046	38.4056	2805.00	977325.4
366	6.2612	38.4257	2900.00	977302.8
367	6.4023	38.3451	1910.00	977625.4
368	6.3742	38.3040	1556.00	977623.4
369	6.3474	38.2787	1535.00	977597.9
370	6.3142	38.2607	1720.00	977561.1
371	6.4207	38.2725	1400.00	977625.3
372	6.4109	38.2465	1442.00	977623.4
373	6.4276	38.2169	1299.00	977651.4
374	6.3901	38.2020	1385.00	977642.8
375	6.3644	38.1573	1402.00	977644.9
376	6.3779	38.0954	1190.00	977685.4
377	6.3040	38.2921	1675.00	977566.1
378	6.2678	38.2863	1765.00	977554.6
379	6.3026	38.2245	1853.00	977544.9
380	6.2673	38.2083	1877.00	977541.8
381	6.2320	38.2102	1850.00	977540.9
382	6.1977	38.2972	1835.00	977545.7
383	6.1645	38.1988	1818.00	977546.6
384	6.1204	38.2031	1890.00	977531.4
385	6.0777	38.2002	2270.00	977458.7
386	6.0775	38.2274	2300.00	977446.4
387	6.0556	38.2448	2520.00	977402.9

388	6.0264	38.2629	2420.00	977426.4
389	6.2893	38.2553	1760.00	977557.4
390	6.2617	38.2526	2000.00	977508.4
391	6.1346	38.1419	1998.00	977520.2
392	6.1027	38.1139	2165.00	977480.1
393	6.0441	38.1131	1970.00	977509.9
394	6.1805	38.1560	1935.00	977531.4
395	6.0360	38.1630	1935.00	977542.7
396	6.0025	38.1527	1700.00	977572.4
397	6.0089	38.1909	2026.00	977518.4
398	6.1913	38.2701	2046.00	977495.2
399	5.0200	36.4800	949.00	977800.9
400	5.0100	36.4500	987.00	977793.9
401	5.0600	36.4200	954.00	977801.9
402	5.0700	36.3900	845.00	977824.7
403	5.0300	36.3700	780.00	977837.8
404	5.0400	36.3300	717.00	977852.1
405	5.0500	36.3000	635.00	977869.4
406	5.0700	36.2700	549.00	977887.9
407	5.0900	36.2300	462.00	977903.9
408	5.1000	36.1900	383.00	977905.7
409	5.1200	36.1500	371.00	977899.6
410	5.1400	36.1200	378.00	977897.7
411	5.1700	36.0900	377.00	977891.9
412	5.1500	36.1700	397.00	977899.7
413	5.1600	36.2000	426.00	977898.4
414	4.9700	36.4800	938.00	977809.9
415	5.2100	36.5300	1081.00	977799.2
416	5.1500	36.5300	1056.00	977804.2
417	5.1100	36.5000	1006.00	977814.8
418	5.0700	36.5100	981.00	977819.9
419	5.0300	36.4900	918.00	977834.2
420	5.0000	36.4700	886.00	977840.3
421	4.9700	36.4900	864.00	977845.4
422	5.1700	36.5500	1033.00	977809.9
423	4.7800	36.1500	405.00	977904.9
424	4.8000	36.1700	410.00	977912.4
425	4.8500	36.1600	411.00	977913.4
426	4.8900	36.1600	405.00	977915.4
427	4.9300	36.1600	413.00	977913.9
428	4.9700	36.1600	406.00	977913.4
429	5.0100	36.1600	409.00	977911.7
430	5.0500	36.1800	434.00	977907.4
431	4.8100	36.0500	354.00	977896.7
432	4.8400	36.0800	352.00	977897.4
433	4.8500	36.1100	353.00	977903.8
434	4.8800	36.1200	346.00	977908.1
435	4.8800	36.1600	356.00	977915.9
436	5.1300	36.2000	386.00	977904.6

437	5.1600	36.1900	362.00	977902.4
438	5.1200	36.2300	439.00	977905.1
439	5.0800	36.2500	492.00	977898.1
440	5.0700	36.2600	536.00	977888.9
441	5.7100	36.4100	471.00	977875.2
442	5.6700	36.4200	487.00	977874.2
443	5.6400	36.4000	488.00	977873.6
444	5.5600	36.3700	450.00	977878.1
445	5.5700	36.3500	452.00	977880.9
446	5.5400	36.3200	461.00	977878.4
447	5.5100	36.2900	447.00	977880.4
448	5.5100	36.2500	413.00	977884.9
449	5.4800	36.2200	395.00	977886.4
450	5.4400	36.2300	401.00	977892.3
451	5.4100	36.2300	402.00	977897.2
452	5.3700	36.2100	415.00	977894.4
453	5.3400	36.2300	437.00	977893.9
454	5.3000	36.2200	406.00	977895.4
455	5.2700	36.2100	421.00	977896.4
456	5.2500	36.2400	451.00	977900.9
457	5.2100	36.2600	449.00	977904.4
458	5.1800	36.2300	473.00	977901.8
459	5.1600	36.2100	452.00	977897.4
460	5.7400	36.4100	537.00	977867.4
461	5.7400	36.4000	532.00	977868.7
462	5.7600	36.3700	572.00	977883.9
463	5.7700	36.3300	462.00	977891.9
464	5.7900	36.3000	456.00	977896.8
465	5.8200	36.2800	444.00	977898.4
466	5.8400	36.2800	444.00	977898.1
467	5.8600	36.2700	460.00	977895.4
468	5.8600	36.2400	685.00	977848.2
469	5.8900	36.2200	610.00	977857.7
470	5.9100	36.1800	610.00	977854.4
471	5.9200	36.1700	651.00	977848.6
472	5.9600	36.1600	603.00	977862.4
473	6.0000	36.1500	614.00	977866.9
474	6.0400	36.1500	516.00	977870.2
475	6.0800	36.1700	574.00	977887.9
476	6.1200	36.1700	600.00	977880.9
477	6.1700	36.1700	612.00	977879.9
478	6.2000	36.1500	583.00	977880.4
479	6.2200	36.1300	564.00	977880.9
480	5.9100	36.1600	673.00	977845.7
481	5.8800	36.1400	672.00	977848.2
482	5.8600	36.1000	609.00	977857.9
483	5.8600	36.0600	531.00	977871.8
484	5.8600	36.0200	481.00	977884.9
485	5.8800	35.9900	451.00	977892.4

486	5.8400	35.9800	455.00	977888.7
487	5.7400	35.9700	439.00	977892.4
488	5.8600	36.5500	1404.00	977671.2
489	5.8900	36.5800	1557.00	977633.4
490	5.9200	36.5800	1648.00	977608.2
491	5.9600	36.5900	1628.00	977610.4
492	5.9800	36.5700	1538.00	977628.4
493	5.9600	36.5400	1419.00	977658.2
494	5.9800	36.5300	1638.00	977610.4
495	5.9700	36.5100	1421.00	977659.1
496	5.9300	36.5000	1524.00	977644.2
497	5.9200	36.5000	1549.00	977637.6
498	5.7900	36.5600	1341.00	977686.4
499	5.7900	36.5900	1528.00	977644.4
500	5.8000	36.6200	1720.00	977602.7
501	5.8200	36.6400	1888.00	977564.3
502	5.8400	36.6800	1867.00	977566.9
503	5.8500	36.7100	1472.00	977641.2
504	5.8700	36.7200	1069.00	977712.9
505	5.9100	36.7500	1026.00	977723.4
506	5.9400	36.7800	1058.00	977717.1
507	5.9700	36.8000	1082.00	977712.4
508	6.0000	36.8300	1044.00	977715.4
509	6.0400	36.8600	1042.00	977714.9
510	6.0600	36.8900	1060.00	977720.2
511	6.0900	36.9200	1138.00	977703.9
512	5.3400	37.4400	1367.00	977657.4
513	5.3800	37.2500	1383.00	977641.8
514	5.3400	37.2500	1451.00	977624.2
515	5.3000	37.2500	1366.00	977640.9
516	5.2800	37.2500	1396.00	977631.4
517	5.3900	37.3400	1373.00	977653.6
518	5.3600	37.3200	1343.00	977657.2
519	5.3200	37.3100	1343.00	977635.8
520	5.3200	37.3100	1487.00	977617.7
521	5.3500	37.4400	1340.00	977665.3
522	5.3700	37.4600	1203.00	977689.9
523	5.4100	37.4800	1169.00	977693.6
524	5.0400	37.3500	1339.00	977661.9
525	5.0100	37.3200	1308.00	977660.7
526	4.9800	37.2900	1308.00	977660.9
527	4.9600	37.2500	1183.00	977689.8
528	4.9500	37.2100	1260.00	977681.9
529	4.9500	37.1700	1303.00	977676.9
530	4.9600	37.1300	1268.00	977683.7
531	4.9800	37.1000	1239.00	977693.8
532	4.9900	37.0600	966.00	977754.3
533	5.0000	37.0400	720.00	977802.1
534	4.9800	37.0100	606.00	977824.9

535	4.9700	36.9800	536.00	977818.4
536	4.9300	37.0000	500.00	977824.9
537	4.8900	37.0000	502.00	977829.7
538	4.8500	37.0000	504.00	977823.1
539	5.0200	37.3700	1372.00	977648.9
540	4.9800	37.3500	1360.00	977647.7
541	4.9500	37.3300	1320.00	977656.4
542	4.9100	37.3100	1298.00	977662.4
543	4.8800	37.2800	1221.00	977682.1
544	4.8500	37.2500	1290.00	977671.4
545	4.8200	37.2300	1194.00	977693.4
546	4.7800	37.2300	1091.00	977716.9
547	4.7300	37.2200	1059.00	977725.4
548	4.6900	37.2200	994.00	977739.2
549	4.6500	37.2400	955.00	977746.9
550	4.6400	37.2700	938.00	977752.9
551	4.6000	37.2900	942.00	977752.3
552	4.5800	37.2500	904.00	977763.4
553	4.5400	37.2400	912.00	977761.6
554	4.5000	37.2300	884.00	977773.4
555	4.4800	37.2100	898.00	977771.9
556	4.4500	37.1800	915.00	977771.4
557	4.4300	37.1500	914.00	977775.7
558	4.4100	37.1300	929.00	977775.7
559	4.4000	37.1800	876.00	977783.4
560	4.3900	37.2200	867.00	977784.6
561	4.3700	37.2600	831.00	977792.4
562	5.0600	37.3800	1424.00	977651.4
563	4.8900	38.1000	1590.00	977583.1
564	4.9900	37.8200	1100.00	977696.9
565	4.9600	37.8000	1054.00	977699.9
566	4.9300	37.7700	1004.00	977716.9
567	4.8900	37.7400	968.00	977726.4
568	4.8500	37.7200	928.00	977732.9
569	4.8100	37.7100	923.00	977734.3
570	4.7700	37.7000	969.00	977726.6
571	4.7500	37.6700	940.00	977735.1
572	4.7400	37.6300	917.00	977742.4
573	4.9600	37.9600	1432.00	977624.8
574	4.9300	37.9400	1387.00	977636.4
575	4.8900	37.9300	1387.00	977649.4
576	4.8500	37.9200	1387.00	977661.9
577	4.8300	37.9000	1193.00	977669.2
578	4.8000	37.8600	1151.00	977690.7
579	4.7700	37.8200	1115.00	977700.8
580	4.7600	37.7900	1053.00	977715.3
581	4.7300	37.7600	1026.00	977719.9
582	4.7500	37.7200	951.00	977728.1
583	4.7400	37.6000	914.00	977743.3

584	4.7200	37.5600	969.00	977735.3
585	4.7300	37.5300	985.00	977738.4
586	4.7200	37.4800	1003.00	977744.9
587	4.7000	37.4400	1033.00	977745.1
588	4.6800	37.4100	999.00	977757.9
589	4.8300	37.9100	1205.00	977702.4
590	4.8100	37.9300	1240.00	977694.4
591	4.7800	37.0000	1206.00	977710.7
592	4.7600	37.0400	1222.00	977703.8
593	4.7300	38.0700	1238.00	977701.1
594	4.7100	38.1200	1251.00	977702.4
595	4.6900	38.1200	1309.00	977691.2
596	4.6800	38.1500	1351.00	977663.7
597	4.6700	38.1900	1372.00	977641.4
598	4.6700	38.2300	1443.00	977619.2
599	5.8700	37.4800	1042.00	977667.4
600	5.8800	37.4600	1058.00	977663.4
601	5.9000	37.4200	1203.00	977639.4
602	5.9000	37.3900	1286.00	977620.4
603	5.8800	37.3800	1253.00	977633.3
604	5.8600	37.3500	1363.00	977614.9
605	4.8100	36.0500	388.00	977896.7
606	5.5200	36.7300	1502.00	977650.7
607	6.0511	37.5583	1226.00	977657.1
608	6.0024	37.5513	1380.00	977622.1
609	5.3359	37.4408	1462.00	977657.1
610	5.3533	37.0335	593.00	977819.1
611	5.7810	37.5622	1415.00	977670.1
612	5.5208	36.7333	1515.00	977635.1
613	5.6408	37.0050	558.00	977824.1
614	4.9927	36.8367	513.00	977824.1
615	4.8562	37.0442	570.00	977833.1
616	5.0630	36.8550	550.00	977847.1
617	5.0000	36.8300	520.00	977848.1
618	4.9982	36.8287	520.00	977829.1
619	5.0053	36.7917	523.00	977852.1
620	4.9947	36.7503	513.00	977855.1
621	4.9500	36.7500	512.00	977855.1
622	4.9120	36.7505	522.00	977849.1
623	4.8668	36.7500	521.00	977848.1
624	4.8303	36.7297	533.00	977847.1
625	4.8300	36.7017	678.00	977828.1
626	4.8472	36.6737	812.00	977805.1
627	4.8738	36.6608	1040.00	977765.1
628	4.8962	36.6134	1070.00	977759.1
629	4.9147	36.5796	998.00	977776.1
630	4.9521	36.5525	967.00	977781.1
631	4.9722	36.5306	925.00	977791.1
632	4.9663	36.4852	940.00	977794.1

633	5.0820	36.8340	925.00	977791.1
634	5.0787	36.8251	942.00	977786.1
635	5.0762	36.8240	1005.00	977779.1
636	4.7052	37.0158	520.00	977843.1
637	4.6063	36.9817	527.00	977845.1
638	4.6337	36.9742	696.00	977848.1
639	4.6958	36.9698	503.00	977829.1
640	4.6837	36.9323	505.00	977830.1
641	4.6697	36.8047	508.00	977831.1
642	4.6992	36.8600	513.00	977834.1
643	4.6868	36.8130	514.00	977839.1
644	4.7403	36.7897	521.00	977836.1
645	4.6989	37.0321	508.00	977844.1
646	4.6087	36.3670	622.00	977860.1
647	4.4833	36.4167	615.00	977869.1
648	4.6104	36.5702	799.00	977816.1
649	4.6083	36.5580	794.00	977818.1
650	4.6238	36.5179	786.00	977820.1
651	4.6232	36.4786	754.00	977826.1
652	4.6307	36.4413	703.00	977841.1
653	4.6215	36.4080	676.00	977848.1
654	4.6611	36.5568	833.00	977806.1
655	4.6944	36.5733	894.00	977796.1
656	4.7284	36.5867	958.00	977778.1
657	4.7503	36.5987	1015.00	977771.1
658	4.7686	36.6199	1050.00	977763.1
659	4.8212	36.6265	1035.00	977767.1
660	4.8675	36.6176	1054.00	977763.1
661	4.5753	36.3002	505.00	977868.1
662	4.6050	36.3408	568.00	977872.1
663	4.9377	36.4710	866.00	977807.1
664	4.9846	36.4543	848.00	977802.1
665	4.8527	36.4545	809.00	977809.1
666	4.8180	36.4320	734.00	977825.1
667	4.7761	36.4033	710.00	977830.1
668	4.7581	36.3797	666.00	977840.1
669	4.7498	36.3368	602.00	977854.1
670	4.7565	36.2921	544.00	977870.1
671	4.7601	36.2547	489.00	977879.1
672	4.7458	36.2184	541.00	977883.1
673	4.7477	36.1733	417.00	977883.1
674	4.7804	36.1507	390.00	977888.1
675	4.8068	36.1124	376.00	977893.1
676	4.8148	36.0728	374.00	977882.1
677	4.8118	36.0490	373.00	977881.1
678	5.0683	35.9172	421.00	977900.1
679	4.7883	35.9833	377.00	977893.1
680	5.8429	36.2918	688.00	977834.1
681	5.8477	36.2537	712.00	977828.1

682	5.8467	36.2670	473.00	977881.1
683	5.7835	36.3038	494.00	977880.1
684	5.7692	36.3407	489.00	977874.1
685	5.7542	36.0400	500.00	977868.1
686	5.6697	36.4137	515.00	977857.1
687	5.7639	36.3897	511.00	977860.1
688	5.7508	36.3800	525.00	977863.1
689	5.7372	36.3992	577.00	977851.1
690	5.7661	36.4294	715.00	977821.1
691	5.7925	36.4833	1314.00	977694.1
692	5.7927	36.6097	1624.00	977619.1
693	5.8312	36.6647	1933.00	977550.1
694	5.8337	36.6830	1930.00	977544.1
695	5.6695	36.6950	1395.00	977645.1
696	5.6920	36.7300	1356.00	977649.1
697	5.7172	36.7637	1380.00	977661.1
698	5.7980	36.8617	1500.00	977627.1
699	5.7820	36.8350	1403.00	977651.1
700	5.7608	36.8127	1400.00	977672.1
701	5.7275	36.7817	1254.00	977698.1
702	5.7508	36.5879	1465.00	977645.1
703	5.7304	36.6144	1394.00	977657.1
704	5.6984	36.6305	1373.00	977670.1
705	5.6516	36.6558	1382.00	977661.1
706	5.6254	36.6790	1365.00	977665.1
707	5.5948	36.6963	1352.00	977664.1
708	5.5625	36.7222	1538.00	977624.1
709	5.5309	36.7280	1577.00	977627.1
710	5.5041	36.7407	1417.00	977651.1
711	5.4703	36.7586	1086.00	977719.1
712	5.4728	36.8025	807.00	977774.1
713	5.4674	36.8401	643.00	977798.1
714	5.4562	36.8742	630.00	977803.1
715	5.4431	36.9143	608.00	977805.1
716	5.4198	36.9456	553.00	977814.1
717	5.3904	36.9792	568.00	977817.1
718	5.4421	36.9245	602.00	977807.1
719	5.4317	36.9288	617.00	977819.1
720	5.6208	36.8667	694.00	977787.1
721	5.5913	36.5958	643.00	977786.1
722	5.5533	36.5872	646.00	977793.1
723	5.5160	36.5800	624.00	977808.1
724	5.4762	36.5808	645.00	977809.1
725	5.4158	36.7963	683.00	977809.1
726	5.3883	36.7700	729.00	977798.1
727	5.3642	36.7483	783.00	977789.1
728	5.3333	36.7325	894.00	977777.1
729	5.3158	36.6900	981.00	977765.1
730	5.2958	36.6683	1261.00	977714.1

731	5.2483	36.6667	1271.00	977719.1
732	5.2383	36.6492	1255.00	977725.1
733	5.2317	36.6008	1263.00	977726.1
734	5.1867	36.5383	1100.00	977764.1
735	5.3433	37.0700	1040.00	977764.1
736	5.3458	37.1100	729.00	977780.1
737	5.5475	37.1475	1000.00	977724.1
738	5.4033	37.1670	1280.00	977676.1
739	5.3892	37.2367	1446.00	977638.1
740	5.3958	37.2967	1470.00	977640.1
741	5.3833	37.3575	1438.00	977657.1
742	5.7029	37.3937	1364.00	977639.1
743	5.6778	37.3764	1575.00	977578.1
744	5.6432	37.3710	2067.00	977484.1
745	5.3403	37.4730	1212.00	977704.1
746	5.3454	37.5175	1137.00	977716.1
747	5.3501	37.5448	1033.00	977738.1
748	5.3394	37.5558	935.00	977751.1
749	5.3205	37.6182	888.00	977756.1
750	5.3244	37.6504	886.00	977745.1
751	5.3482	37.7011	974.00	977727.1
752	5.3794	37.7371	1226.00	977689.1
753	5.0613	37.3830	1453.00	977669.7
754	5.0530	37.3710	1471.00	977666.6
755	4.8340	36.7778	512.00	977852.8
756	4.6143	36.4000	682.00	977861.9
757	4.6152	36.3880	659.00	977866.3
758	4.6110	36.3717	622.00	977874.7
759	4.6045	36.3575	615.00	977876.7
760	4.6043	36.3495	578.00	977885.1
761	4.5997	36.3370	558.00	977888.6
762	4.5912	36.3235	530.00	977887.9
763	4.5783	36.3078	503.00	977885.2
764	4.5723	36.2918	479.00	977885.7
765	4.5637	36.2767	448.00	977890.9
766	4.5553	36.2645	417.00	977894.4
767	4.5558	36.2447	399.00	977897.4
768	4.5582	36.2280	386.00	977901.4
769	4.5700	36.2215	384.00	977902.2
770	4.5855	36.2163	380.00	977904.4
771	4.6010	36.2142	374.00	977906.7
772	4.6167	36.2070	376.00	977908.1
773	4.6322	36.2022	381.00	977908.9
774	4.6522	36.1972	390.00	977908.1
775	4.6678	36.1850	393.00	977905.3
776	4.6833	36.1758	390.00	977904.3
777	4.7018	36.1753	404.00	977900.1
778	4.7133	36.1697	408.00	977899.3
779	4.7313	36.1700	398.00	977901.7

780	4.7450	36.1587	382.00	977904.2
781	4.7577	36.1462	369.00	977905.2
782	4.7713	36.1367	369.00	977904.4
783	4.7837	36.1258	370.00	977902.8
784	4.7955	36.1143	370.00	977900.8
785	4.8050	36.1038	371.00	977898.6
786	4.8188	36.0878	373.00	977897.1
787	4.8353	36.0745	373.00	977897.3
788	4.8183	35.9968	381.00	977909.7
789	4.8212	36.0160	372.00	977908.7
790	4.8285	36.0366	372.00	977900.7
791	4.8350	36.0570	374.00	977897.1
792	4.8358	36.0733	373.00	977897.4
793	5.0180	35.9650	434.00	977901.2
794	5.0008	35.9740	413.00	977907.9
795	4.9823	35.9763	401.00	977911.9
796	4.9638	35.9800	394.00	977914.4
797	4.9447	35.9750	391.00	977914.1
798	4.9280	35.9667	388.00	977912.6
799	4.9085	35.9605	385.00	977908.9
800	4.8885	35.9607	389.00	977908.4
801	4.8687	35.9655	394.00	977906.4
802	4.8508	35.9822	386.00	977906.8
803	4.8350	35.9780	378.00	977910.2
804	4.8007	35.9743	376.00	977911.1
805	4.7838	35.9727	377.00	977910.2
806	4.7708	35.9690	379.00	977907.3
807	4.7513	35.9647	373.00	977906.4
808	4.7318	35.9642	374.00	977905.9
809	4.7128	35.9620	375.00	977903.9
810	4.6957	35.9602	373.00	977902.8
811	4.6820	35.9575	369.00	977903.7
812	4.6603	35.9548	368.00	977901.1
813	4.6417	35.9540	369.00	977899.9
814	4.6267	35.9540	376.00	977897.2
815	5.3688	36.9127	599.00	977832.9
816	5.3500	36.9227	605.00	977832.2
817	5.3375	36.9297	556.00	977840.6
818	5.3193	36.9262	552.00	977842.9
819	5.3068	36.9287	549.00	977842.6
820	5.2918	36.9242	562.00	977837.9
821	5.2748	36.9167	558.00	977836.4
822	5.2600	36.9115	550.00	977833.3
823	5.2452	36.9042	555.00	977831.9
824	5.2315	36.8985	544.00	977833.6
825	5.2125	36.8952	534.00	977830.3
826	5.1957	36.8868	532.00	977831.3
827	5.1775	36.8838	528.00	977833.4
828	5.1628	36.8733	528.00	977833.1

829	5.1478	36.8632	528.00	977836.7
830	5.1277	36.8605	526.00	977836.9
831	5.1110	36.8538	525.00	977841.1
832	5.0942	36.8522	521.00	977847.2
833	5.0777	36.8540	520.00	977854.3
834	5.0602	36.8557	530.00	977849.6
835	5.0422	36.8533	518.00	977848.4
836	5.0258	36.8615	515.00	977838.4
837	5.0075	36.8618	515.00	977835.7
838	4.9888	36.8613	513.00	977838.9
839	4.9813	36.8530	513.00	977839.8
840	4.9788	36.8320	514.00	977847.4
841	4.9907	36.8212	508.00	977862.9
842	5.0017	36.8157	503.00	977867.7
843	5.0078	36.8007	514.00	977865.9
844	5.0177	36.7887	505.00	977870.1
845	5.0158	36.7725	502.00	977869.2
846	5.0130	36.7558	511.00	977867.9
847	4.9983	36.7472	502.00	977870.4
848	4.9812	36.7437	502.00	977866.9
849	4.9625	36.7507	504.00	977864.6
850	4.9465	36.7517	506.00	977864.2
851	4.9238	36.7517	501.00	977864.2
852	4.9082	36.7565	511.00	977862.6
853	4.8912	36.7587	504.00	977863.9
854	4.8750	36.7653	501.00	977860.9
855	4.8610	36.7762	502.00	977854.8
856	4.8430	36.7855	500.00	977852.3
857	4.8210	36.7878	500.00	977849.9
858	4.8035	36.7843	500.00	977851.6
859	4.7905	36.7715	501.00	977857.3
860	4.7745	36.7678	501.00	977860.3
861	4.7597	36.7572	501.00	977861.7
862	4.7580	36.7762	501.00	977852.8
863	4.7567	36.7938	501.00	977850.1
864	4.7548	36.8120	501.00	977848.6
865	4.7535	36.8300	501.00	977848.4
866	4.7517	36.8478	501.00	977845.6
867	4.7500	36.8650	501.00	977841.6
868	4.7405	36.7572	502.00	977863.1
869	4.7215	36.7572	499.00	977865.2
870	4.7012	36.7570	498.00	977867.1
871	4.6813	36.7582	501.00	977868.8
872	4.6848	36.7485	501.00	977870.9
873	4.6747	36.7732	501.00	977864.9
874	4.6672	36.7897	501.00	977859.4
875	4.6607	36.8060	501.00	977858.4
876	4.6527	36.8232	501.00	977859.1
877	4.6455	36.8393	501.00	977858.4

878	4.6378	36.8555	501.00	977858.4
879	4.6300	36.8713	501.00	977855.1
880	4.6213	36.8872	501.00	977852.2
881	4.6140	36.9017	501.00	977857.1
882	4.6058	36.9187	499.00	977859.9
883	4.5983	36.9353	501.00	977859.7
884	4.5908	36.9528	502.00	977863.6
885	4.5822	36.9707	513.00	977862.6
886	4.5802	36.9818	531.00	977861.3
887	4.6228	36.9268	501.00	977858.2
888	4.6298	36.9432	502.00	977859.4
889	4.6203	36.9568	501.00	977861.1
890	4.6373	36.9715	502.00	977861.2
891	4.6547	36.9753	502.00	977858.4
892	4.6680	36.9837	501.00	977852.9
893	4.6845	36.9922	501.00	977851.8
894	4.6958	37.0035	500.00	977853.3
895	4.7100	36.9925	500.00	977844.8
896	4.7305	36.9860	500.00	977841.4
897	4.7462	36.9953	500.00	977842.9
898	4.7532	37.0103	499.00	977846.3
899	4.7715	37.0067	499.00	977844.4
900	4.7938	37.0077	498.00	977843.3
901	4.8117	37.0083	500.00	977844.4
902	4.8300	37.0053	500.00	977842.4
903	4.9595	37.1287	1354.00	977701.9
904	4.9645	37.1220	1349.00	977701.6
905	4.9748	37.1080	1404.00	977691.9
906	4.9800	37.0918	1221.00	977729.9
907	4.9913	37.0780	1143.00	977745.3
908	4.9988	37.0648	1012.00	977771.7
909	5.0027	37.0562	973.00	977777.8
910	5.0020	37.0460	776.00	977815.2
911	4.9540	37.1465	1276.00	977716.4
912	4.9455	37.1647	1374.00	977694.7
913	4.9412	37.1833	1356.00	977698.8
914	4.9902	37.0328	702.00	977827.8
915	4.9829	37.0222	679.00	977834.4
916	4.9805	37.0098	616.00	977843.9
917	4.9770	36.9935	569.00	977839.9
918	4.9668	36.9850	548.00	977835.6
919	4.9507	36.9905	529.00	977837.1
920	4.9338	36.9950	505.00	977841.3
921	4.9157	36.9995	500.00	977842.9
922	4.9999	37.0040	503.00	977844.2
923	4.8832	37.0065	500.00	977847.1
924	4.8655	37.0015	500.00	977841.3
925	4.8468	37.0017	499.00	977842.4
926	4.9458	37.1950	1381.00	977693.4

927	4.9502	37.2092	1342.00	977698.4
928	4.9587	37.2240	1282.00	977705.4
929	4.9633	37.2408	1237.00	977710.2
930	4.9678	37.2570	1281.00	977698.8
931	4.9760	37.2712	1338.00	977685.2
932	4.9838	37.2862	1389.00	977675.9
933	4.9907	37.2993	1308.00	977691.2
934	5.0008	37.3128	1353.00	977681.8
935	5.0145	37.3238	1410.00	977671.4
936	5.0295	37.3333	1414.00	977672.9
937	5.0375	37.3515	1405.00	977678.4
938	5.0488	37.3665	1428.00	977675.9
939	6.5727	38.4773	2479.00	977394.6
940	6.5673	38.4898	2564.00	977374.2
941	6.5623	38.4955	2629.00	977362.9
942	6.5583	38.4947	2666.00	977355.1
943	6.5507	38.4865	2703.00	977347.1
944	6.5347	38.4765	2749.00	977335.6
945	6.5227	38.4802	2747.00	977335.9
946	6.5137	38.4897	2802.00	977324.7
947	6.5090	38.5053	2769.00	977333.2
948	6.5073	38.5198	2795.00	977327.6
949	6.4903	38.5333	2775.00	977333.2
950	6.4687	38.5390	2767.00	977335.7
951	6.4553	38.5413	2726.00	977342.9
952	6.4412	38.5557	2742.00	977339.8
953	6.4278	38.5713	2702.00	977351.1
954	6.4147	38.5802	2722.00	977346.1
955	6.3953	38.5927	2709.00	977349.8
956	6.3833	38.5965	2750.00	977340.7
957	6.3725	38.6125	2741.00	977342.4
958	6.3633	38.6250	2686.00	977353.2
959	6.3465	38.6350	2706.00	977347.7
960	6.3315	38.6500	2650.00	977361.4
961	6.3393	38.6622	2688.00	977352.4
962	6.3335	38.6667	2673.00	977355.4
963	6.3217	38.6682	2681.00	977354.7
964	6.3015	38.6683	2651.00	977362.3
965	6.2848	38.6688	2682.00	977357.7
966	6.2727	38.6702	2681.00	977357.4
967	6.2737	38.6938	2644.00	977364.6
968	6.2567	38.7085	2678.00	977358.1
969	6.2437	38.7122	2686.00	977355.4
970	6.2260	38.7203	2584.00	977376.6
971	4.5433	39.0753	1046.00	977731.9
972	4.4083	37.1648	905.00	977798.9
973	4.4157	37.1163	984.00	977791.6
974	4.8285	38.1922	1599.00	977602.3
975	4.8108	38.1955	1604.00	977600.9

976	4.7910	38.1975	1602.00	977601.7
977	4.7732	38.2005	1608.00	977601.9
978	4.7547	38.2010	1587.00	977607.3
979	4.7367	38.1990	1538.00	977616.7
980	4.7212	38.2047	1527.00	977617.4
981	4.7100	38.2142	1491.00	977629.4
982	4.6882	38.2307	1508.00	977629.7
983	4.6688	38.2418	1527.00	977624.1
984	4.6510	38.2467	1538.00	977621.2
985	4.6275	38.2500	1529.00	977624.1
986	4.6003	38.2477	1511.00	977628.4
987	4.5775	38.2505	1567.00	977618.2
988	4.5590	38.2550	1598.00	977612.1
989	4.5420	38.2630	1644.00	977604.3
990	4.5232	38.2715	1676.00	977598.8
991	4.5040	38.2765	1626.00	977609.9
992	4.4800	38.2785	1606.00	977614.8
993	4.4550	38.2800	1612.00	977613.4
994	4.4355	38.2795	1574.00	977621.8
995	4.4172	38.2788	1540.00	977630.4
996	4.3982	38.2787	1541.00	977630.4
997	4.3797	38.2777	1507.00	977638.3
998	4.3612	38.2815	1482.00	977644.1
999	4.3433	38.2853	1482.00	977645.1
1000	4.3227	38.2855	1504.00	977641.8
1001	4.3030	38.2828	1511.00	977640.9
1002	4.2833	38.2770	1523.00	977639.1
1003	4.2642	38.2807	1495.00	977645.2
1004	4.2343	38.2727	1571.00	977632.6
1005	4.2007	38.2747	1568.00	977633.1
1006	4.1848	38.2803	1544.00	977637.1
1007	4.1657	38.2760	1545.00	977637.9
1008	4.1420	38.2835	1594.00	977627.8
1009	4.1230	38.2790	1706.00	977607.3
1010	4.1070	38.2867	1829.00	977580.8
1011	4.0892	38.2972	1915.00	977566.8
1012	4.0753	38.3113	1898.00	977569.6
1013	4.0648	38.3198	1858.00	977576.9
1014	4.0417	38.3250	1677.00	977613.9
1015	5.6238	38.2318	1786.00	977556.8
1016	5.6198	38.2142	1766.00	977562.7
1017	5.6173	38.1953	1878.00	977538.1
1018	5.6173	38.1760	1902.00	977536.1
1019	5.6073	38.1567	1921.00	977536.1
1020	5.6040	38.1367	1792.00	977561.2
1021	5.5963	38.1173	1736.00	977571.4
1022	5.5820	38.1018	1702.00	977577.9
1023	5.5727	38.0920	1750.00	977569.9
1024	5.5632	38.0773	1822.00	977555.3

1025	5.5680	38.0598	1816.00	977559.1
1026	5.5678	38.0372	1884.00	977545.9
1027	5.5602	38.0142	1890.00	977545.2
1028	5.5467	38.0027	2019.00	977522.9
1029	5.5323	38.0067	2136.00	977500.4
1030	5.5200	38.0068	2099.00	977510.9
1031	5.5108	37.9905	2066.00	977521.7
1032	5.4968	37.9798	1961.00	977542.8
1033	5.4825	37.9717	1871.00	977559.4
1034	5.4623	37.9617	1956.00	977538.6
1035	5.4753	37.9455	1850.00	977559.3
1036	5.4785	37.9255	1678.00	977590.7
1037	5.4768	37.9050	1614.00	977601.9
1038	5.4775	37.8832	1787.00	977573.2
1039	5.4647	37.8818	1799.00	977570.1
1040	5.4480	37.8762	1763.00	977578.2
1041	5.4420	37.8560	1801.00	977571.4
1042	5.4402	37.8388	1665.00	977598.7
1043	5.4440	37.8253	1761.00	977579.4
1044	5.4463	37.8082	1918.00	977544.4
1045	5.4602	37.8087	1988.00	977529.4
1046	4.5355	39.0307	1073.00	977726.9
1047	4.5312	39.0082	1083.00	977724.9
1048	4.5245	38.9870	1097.00	977724.2
1049	4.5153	38.9698	1104.00	977723.3
1050	4.5068	38.9508	1116.00	977719.6
1051	4.5043	38.9290	1130.00	977716.1
1052	4.5005	38.9093	1138.00	977713.4
1053	4.4967	38.8983	1141.00	977711.8
1054	4.4963	38.8793	1151.00	977707.7
1055	4.4962	38.8632	1161.00	977703.6
1056	4.4982	38.8452	1170.00	977702.6
1057	4.4940	38.8272	1178.00	977699.6
1058	4.4925	38.8078	1178.00	977699.4
1059	4.4940	38.7818	1194.00	977698.9
1060	4.4937	38.7620	1200.00	977702.1
1061	4.4918	38.7468	1207.00	977705.9
1062	4.4887	38.7285	1216.00	977706.7
1063	4.4858	38.7103	1224.00	977699.8
1064	4.4823	38.6980	1233.00	977694.9
1065	4.4858	38.6787	1242.00	977684.4
1066	4.4940	38.6522	1252.00	977679.8
1067	4.5000	38.6322	1267.00	977677.7
1068	4.5068	38.6148	1277.00	977676.8
1069	4.5097	38.5970	1285.00	977675.3
1070	4.5062	38.5765	1295.00	977673.2
1071	4.4940	38.5623	1298.00	977673.1
1072	4.4765	38.5480	1307.00	977672.2
1073	4.4663	38.5402	1321.00	977668.9

1074	4.4453	38.5278	1340.00	977667.2
1075	4.4295	38.5088	1373.00	977660.7
1076	4.4172	38.5008	1399.00	977655.9
1077	4.4038	38.4810	1433.00	977650.4
1078	4.3902	38.4613	1422.00	977653.1
1079	4.3800	38.4500	1444.00	977649.2
1080	4.3637	38.4265	1424.00	977654.1
1081	4.3483	38.4142	1424.00	977653.8
1082	4.3372	38.4075	1448.00	977649.9
1083	4.3198	38.4037	1466.00	977646.9
1084	4.2995	38.4017	1430.00	977654.6
1085	4.2745	38.3977	1411.00	977659.6
1086	4.2558	38.3902	1429.00	977657.6
1087	4.2303	38.3818	1487.00	977645.9
1088	4.2083	38.3850	1497.00	977645.1
1089	4.1948	38.3613	1525.00	977641.4
1090	4.1860	38.3442	1503.00	977645.3
1091	4.1785	38.3323	1506.00	977644.7
1092	4.1683	38.3148	1522.00	977643.2
1093	4.1588	38.2998	1544.00	977637.1
1094	4.1700	38.2615	1552.00	977635.7
1095	4.1760	38.2433	1575.00	977633.8
1096	4.1887	38.2352	1589.00	977632.8
1097	4.1987	38.2200	1595.00	977631.2
1098	4.2050	38.2035	1592.00	977630.6
1099	4.2133	38.1833	1598.00	977626.9
1100	4.2235	38.1672	1565.00	977633.4
1101	4.2380	38.1448	1534.00	977638.9
1102	4.2608	38.1262	1513.00	977641.3
1103	4.2755	38.1150	1510.00	977642.9
1104	4.2918	38.1008	1497.00	977645.3
1105	4.3120	38.0807	1487.00	977648.6
1106	4.3328	38.0702	1512.00	977642.7
1107	4.3563	38.0678	1489.00	977646.9
1108	4.3742	38.0615	1449.00	977655.6
1109	4.0067	38.3683	1453.00	977654.7
1110	3.9933	38.3795	1461.00	977652.9
1111	3.9683	38.3917	1442.00	977656.4
1112	3.9500	38.4033	1394.00	977666.7
1113	3.9267	38.4200	1377.00	977669.6
1114	3.9083	38.4300	1369.00	977671.6
1115	3.8917	38.4467	1368.00	977672.9
1116	3.8667	38.4667	1337.00	977678.4
1117	4.0168	38.3532	1512.00	977641.9
1118	4.0392	38.3622	1546.00	977634.2
1119	4.0605	38.3625	1540.00	977633.8
1120	4.0282	38.3337	1544.00	977634.9
1121	4.0092	38.3227	1509.00	977642.6
1122	3.9912	38.3117	1492.00	977648.3

1123	3.9833	38.2833	1491.00	977650.8
1124	3.9633	38.2767	1490.00	977652.2
1125	3.9450	38.2683	1482.00	977654.3
1126	3.9300	38.2500	1492.00	977651.8
1127	4.3177	38.3132	1470.00	977647.4
1128	4.2802	38.3378	1434.00	977654.2
1129	4.2547	38.3603	1440.00	977654.2
1130	4.3963	38.0557	1474.00	977650.4
1131	4.4180	38.0452	1480.00	977648.9
1132	4.4287	38.0237	1425.00	977659.3
1133	4.4327	38.0002	1381.00	977670.1
1134	4.4433	37.9797	1338.00	977678.4
1135	4.4552	37.9800	1308.00	977682.8
1136	4.4653	37.9417	1272.00	977685.4
1137	4.4720	37.9232	1249.00	977687.6
1138	4.4753	37.9000	1218.00	977691.9
1139	4.4787	37.8825	1191.00	977697.3
1140	4.4892	37.8623	1187.00	977697.8
1141	4.4883	37.8500	1187.00	977697.1
1142	4.4660	37.8385	1167.00	977700.9
1143	4.4542	37.8257	1144.00	977708.2
1144	4.4425	37.8102	1126.00	977708.6
1145	4.4418	37.7883	1118.00	977710.2
1146	4.4435	37.7662	1106.00	977715.7
1147	4.4432	37.7467	1087.00	977720.9
1148	4.4268	37.7965	1111.00	977711.9
1149	4.4032	37.7832	1096.00	977715.7
1150	4.3863	37.7608	1084.00	977721.1
1151	4.3620	37.7453	1055.00	977726.9
1152	4.3247	37.7353	1013.00	977734.9
1153	4.2960	37.7293	989.00	977743.2
1154	4.2592	37.7085	961.00	977747.8
1155	4.2530	37.6908	972.00	977748.9
1156	4.2470	37.6703	960.00	977752.6
1157	4.2423	37.6487	952.00	977756.2
1158	4.2333	37.6333	928.00	977761.8
1159	4.2230	37.6147	886.00	977769.6
1160	4.2057	37.5943	855.00	977778.1
1161	4.2280	37.5767	825.00	977783.8
1162	4.2423	37.5628	835.00	977781.9
1163	4.2582	37.5458	839.00	977781.2
1164	4.2745	37.5253	831.00	977782.8
1165	4.2907	37.5137	858.00	977780.3
1166	4.3073	37.5000	923.00	977771.1
1167	4.3242	37.4897	949.00	977767.9
1168	4.3482	37.4870	967.00	977765.1
1169	4.3505	37.4632	954.00	977771.9
1170	4.3535	37.4447	944.00	977776.4
1171	4.3588	37.4255	934.00	977779.9

1172	4.3650	37.4050	925.00	977784.4
1173	4.3660	37.3865	952.00	977781.8
1174	4.3630	37.3680	951.00	977785.8
1175	4.3672	37.3483	945.00	977787.8
1176	4.3728	37.3265	938.00	977789.9
1177	4.3747	37.3152	926.00	977792.8
1178	4.3758	37.2952	902.00	977797.9
1179	4.3805	37.2702	897.00	977798.1
1180	4.3820	37.2510	845.00	977809.2
1181	4.3868	37.2335	886.00	977800.9
1182	4.4015	37.2090	882.00	977801.4
1183	4.4047	37.1887	883.00	977801.6
1184	4.4202	37.0960	1045.00	977783.7
1185	7.1003	38.4842	1690.00	977569.1
1186	7.1048	38.4758	1692.00	977568.9
1187	7.1106	38.4687	1685.00	977570.3
1188	7.1206	38.4665	1683.00	977572.4
1189	7.1249	38.4585	1682.00	977575.6
1190	7.1275	38.4495	1686.00	977575.4
1191	7.1305	38.4409	1695.00	977575.3
1192	7.1278	38.4323	1681.00	977554.7
1193	7.1261	38.4231	1683.00	977582.9
1194	7.1180	38.4181	1689.00	977583.9
1195	7.1093	38.4159	1699.00	977580.4
1196	7.1008	38.4105	1714.00	977575.9
1197	7.0926	38.4054	1715.00	977573.4
1198	7.0870	38.4007	1714.00	977572.2
1199	7.0784	38.3964	1700.00	977574.7
1200	7.0704	38.3914	1693.00	977575.4
1201	7.0696	38.3854	1694.00	977573.8
1202	7.0611	38.3802	1691.00	977572.1
1203	7.0534	38.3754	1691.00	977570.4
1204	7.0463	38.3745	1693.00	977568.9
1205	7.0398	38.3748	1693.00	977568.3
1206	7.0395	38.3655	1699.00	977566.3
1207	7.0379	38.3558	1713.00	977559.4
1208	7.0347	38.3471	1693.00	977563.2
1209	7.0390	38.3403	1698.00	977553.1
1210	7.0426	38.3344	1703.00	977559.9
1211	7.0812	38.4868	1690.00	977565.9
1212	7.0721	38.4889	1695.00	977560.6
1213	7.0627	38.4911	1699.00	977558.6
1214	7.0534	38.4933	1703.00	977559.9
1215	7.0445	38.4953	1711.00	977557.3
1216	7.0352	38.4976	1727.00	977554.2
1217	7.0267	38.4996	1722.00	977553.9
1218	7.0172	38.5018	1728.00	977551.9
1219	7.0085	38.5012	1709.00	977551.1
1220	7.1111	38.4909	1702.00	977566.9

1221	7.1038	38.4864	1693.00	977569.1
1222	7.0958	38.4815	1682.00	977571.4
1223	7.0894	38.4850	1681.00	977570.9
1224	7.0388	38.6102	1730.00	977556.6
1225	7.0298	38.6106	1722.00	977558.9
1226	7.0215	38.6068	1722.00	977558.3
1227	7.0231	38.6001	1709.00	977556.9
1228	7.0174	38.5925	1704.00	977555.4
1229	7.0110	38.5863	1713.00	977551.2
1230	7.0017	38.5843	1717.00	977554.4
1231	7.1411	38.5849	1973.00	977511.8
1232	7.1323	38.5865	1953.00	977518.7
1233	7.1267	38.5939	1904.00	977531.9
1234	7.1219	38.6011	1844.00	977545.9
1235	7.1173	38.6080	1797.00	977556.1
1236	7.1103	38.6138	1752.00	977563.4
1237	7.1021	38.6138	1734.00	977562.4
1238	7.0932	38.6125	1726.00	977559.9
1239	7.0846	38.6128	1730.00	977557.7
1240	7.0746	38.6137	1722.00	977558.4
1241	7.0655	38.6130	1717.00	977560.9
1242	7.0570	38.6104	1718.00	977558.7
1243	7.0481	38.6103	1735.00	977555.4
1244	7.0883	38.3120	2072.00	977479.9
1245	7.0904	38.3017	2077.00	977480.9
1246	7.0925	38.2922	2080.00	977482.2
1247	7.0942	38.2822	2055.00	977491.2
1248	7.0939	38.2719	2019.00	977504.7
1249	7.0947	38.2621	1964.00	977525.9
1250	7.0874	38.2587	1937.00	977525.9
1251	7.1462	38.3765	1771.00	977570.1
1252	7.1373	38.3761	1785.00	977570.4
1253	7.1310	38.3758	1773.00	977570.2
1254	7.0850	38.6217	1760.00	977553.3
1255	7.0840	38.6311	1827.00	977539.4
1256	7.0812	38.6392	1885.00	977525.4
1257	7.0816	38.6414	2006.00	977499.4
1258	7.1416	38.3534	1840.00	977555.4
1259	7.1372	38.3535	1858.00	977552.2
1260	7.1282	38.3534	1849.00	977554.7
1261	7.1191	38.3532	1837.00	977554.4
1262	7.1436	38.5107	1718.00	977564.4
1263	7.1357	38.5059	1709.00	977565.4
1264	7.1277	38.5010	1702.00	977566.6
1265	6.9996	38.4991	1695.00	977555.2
1266	7.0918	38.3986	1715.00	977573.6
1267	7.0964	38.3911	1719.00	977573.6
1268	7.1049	38.3914	1728.00	977572.9
1269	7.1098	38.3835	1738.00	977569.4

1270	7.1150	38.3752	1756.00	977566.9
1271	7.1131	38.3694	1773.00	977562.7
1272	7.1136	38.3600	1806.00	977557.2
1273	7.1079	38.3533	1887.00	977529.1
1274	7.1025	38.3498	1766.00	977506.4
1275	7.0959	38.3448	1991.00	977498.7
1276	7.0959	38.3448	1991.00	977498.7
1277	7.0922	38.3366	2047.00	977483.9
1278	7.0875	38.3304	2030.00	977487.6
1279	7.0885	38.3168	2064.00	977607.4
1280	7.0941	38.3119	2070.00	977482.1
1281	7.1041	38.3080	2102.00	977477.6
1282	7.1115	38.3068	2113.00	977479.2
1283	7.1210	38.3078	2121.00	977481.7
1284	7.1304	38.4406	1695.00	977575.4
1285	7.1373	38.4349	1706.00	977578.4
1286	7.1458	38.4314	1709.00	977580.2
1287	7.1484	38.2781	2010.00	977514.4
1288	7.1474	38.2869	2048.00	977506.4
1289	7.1462	38.2963	2085.00	977498.9
1290	7.1413	38.3032	2105.00	977492.7
1291	7.1330	38.3075	2139.00	977479.9
1292	7.1238	38.3079	2110.00	977484.8
1293	7.1494	38.4474	1734.00	977571.4
1294	7.1449	38.4430	1734.00	977570.2
1295	7.1459	38.4356	1717.00	977578.4
1296	7.1487	38.4309	1708.00	977578.2
1297	7.1478	38.2782	2010.00	977514.1
1298	7.1468	38.2870	2047.00	977505.9
1299	7.1456	38.2964	2085.00	977498.6
1300	7.1407	38.3033	2105.00	977492.3
1301	7.1324	38.3076	2139.00	977479.7
1302	7.1232	38.3080	2110.00	977484.4
1303	7.1455	38.3535	1840.00	977555.1
1304	7.1366	38.3536	1858.00	977551.9
1305	7.1276	38.3535	1844.00	977554.4
1306	7.1185	38.3533	1837.00	977553.9
1307	7.1456	38.3766	1771.00	977569.8
1308	7.1367	38.3762	1785.00	977570.2
1309	7.1304	38.3759	1773.00	977569.8
1310	7.1298	38.4407	1695.00	977575.2
1311	7.1367	38.4350	1706.00	977578.2
1312	7.1452	38.4315	1709.00	977579.9
1313	7.0912	38.3987	1715.00	977571.1
1314	7.0958	38.3912	1719.00	977573.3
1315	7.1043	38.3915	1728.00	977572.7
1316	7.1092	38.3836	1738.00	977569.1
1317	7.1145	38.3753	1756.00	977566.4
1318	7.1125	38.3695	1773.00	977562.4

1319	7.1130	38.3601	1806.00	977556.9
1320	7.1073	38.3534	1887.00	977528.8
1321	7.1020	38.3499	1966.00	977506.2
1322	7.0953	38.3449	1991.00	977498.4
1323	7.0916	38.3367	2047.00	977483.7
1324	7.0869	38.3305	2030.00	977487.3
1325	7.0924	38.3231	2042.00	977486.7
1326	7.0879	38.3169	2064.00	977480.9
1327	7.0935	38.3120	2070.00	977481.7
1328	7.1035	38.3081	2102.00	977477.3
1329	7.1109	38.3069	2113.00	977478.9
1330	7.1204	38.3079	2121.00	977489.4
1331	7.0997	38.4843	1690.00	977568.8
1332	7.1042	38.4759	1692.00	977568.4
1333	7.1100	38.4688	1685.00	977569.9
1334	7.1200	38.4666	1683.00	977572.1
1335	7.1243	38.4586	1682.00	977575.3
1336	7.1269	38.4496	1686.00	977575.1
1337	7.1299	38.4410	1695.00	977574.9
1338	7.1272	38.4324	1681.00	977581.3
1339	7.1255	38.4232	1683.00	977582.6
1340	7.1174	38.4182	1689.00	977583.4
1341	7.1087	38.4160	1699.00	977580.2
1342	7.1002	38.4106	1714.00	977574.9
1343	7.0920	38.4055	1715.00	977573.1
1344	7.0865	38.4008	1714.00	977571.8
1345	7.0778	38.3965	1700.00	977574.4
1346	7.0698	38.3915	1699.00	977575.2
1347	7.0690	38.3855	1694.00	977573.4
1348	7.0605	38.3803	1691.00	977574.8
1349	7.0528	38.3755	1691.00	977570.2
1350	7.0457	38.3746	1693.00	977568.6
1351	7.0392	38.3749	1693.00	977567.9
1352	7.0389	38.3656	1699.00	977565.9
1353	7.0373	38.3559	1713.00	977559.1
1354	7.0341	38.3472	1693.00	977562.8
1355	7.0384	38.3404	1698.00	977561.7
1356	7.0420	38.3345	1703.00	977559.4
1357	7.1010	38.4572	1966.00	977521.3
1358	7.1488	38.4475	1734.00	977570.4
1359	7.1443	38.4431	1734.00	977569.9
1360	7.1453	38.4357	1717.00	977577.9
1361	7.1481	38.4310	1708.00	977577.9
1362	7.1430	38.5108	1718.00	977564.2
1363	7.1351	38.5060	1709.00	977564.1
1364	7.1271	38.5011	1702.00	977566.2
1365	7.1191	38.4961	1700.00	977566.9
1366	7.1105	38.4910	1702.00	977566.6
1367	7.1032	38.4865	1693.00	977568.7

1368	7.0952	38.4816	1682.00	977570.9
1369	7.0888	38.4851	1681.00	977570.4
1370	7.0806	38.4869	1690.00	977565.6
1371	7.0715	38.4890	1695.00	977560.2
1372	7.0621	38.4912	1699.00	977558.2
1373	7.0528	38.4934	1703.00	977559.4
1374	7.0439	38.4954	1711.00	977556.9
1375	7.0346	38.4977	1727.00	977553.8
1376	7.0261	38.4997	1722.00	977553.4
1377	7.0166	38.5019	1728.00	977551.4
1378	7.0079	38.5013	1709.00	977550.8
1379	6.9990	38.4992	1695.00	977554.8
1380	7.1405	38.5850	1973.00	977511.4
1381	7.1317	38.5866	1953.00	977518.3
1382	7.1352	38.5939	1904.00	977531.6
1383	7.1213	38.6012	1844.00	977545.6
1384	7.1167	38.6081	1797.00	977555.7
1385	7.1097	38.6139	1752.00	977563.1
1386	7.1015	38.6139	1734.00	977562.2
1387	7.0926	38.6126	1726.00	977559.4
1388	7.0841	38.6129	1730.00	977557.3
1389	7.0740	38.6138	1722.00	977558.2
1390	7.0649	38.6131	1717.00	977560.4
1391	7.0564	38.6105	1718.00	977558.3
1392	7.0475	38.6104	1735.00	977554.9
1393	7.0382	38.6103	1730.00	977556.2
1394	7.0292	38.6106	1722.00	977558.7
1395	7.0209	38.6069	1722.00	977557.9
1396	7.0225	38.6002	1709.00	977556.7
1397	7.0168	38.5926	1704.00	977555.1
1398	7.0104	38.5864	1713.00	977550.9
1399	7.0012	38.5844	1717.00	977553.9
1400	6.9952	38.5783	1709.00	977558.3
1401	6.9882	38.5741	1706.00	977555.3
1402	6.9839	38.5655	1706.00	977556.9
1403	6.9798	38.5571	1704.00	977554.6
1404	6.9791	38.5474	1699.00	977554.6
1405	6.9838	38.5397	1701.00	977552.7
1406	6.9850	38.5301	1700.00	977552.8
1407	6.9840	38.5206	1697.00	977552.8
1408	6.9848	38.5111	1699.00	977554.8
1409	6.9867	38.5024	1695.00	977558.4
1410	6.9915	38.4966	1693.00	977557.3
1411	7.1349	38.7114	2441.00	977397.2
1412	7.1028	38.7450	2555.00	977369.2
1413	7.0773	38.7760	2654.00	977344.4
1414	7.0513	38.8120	2657.00	977338.7
1415	7.0309	38.8534	2626.00	977347.3
1416	7.0237	38.8951	2602.00	977354.4

1417	7.0255	38.9401	2603.00	977355.6
1418	7.0246	38.9833	2584.00	977353.7
1419	7.0124	39.0276	2565.00	977352.9
1420	7.0056	39.0616	2517.00	977364.7
1421	7.0034	39.1064	2497.00	977364.9
1422	7.1300	38.3700	1880.00	977521.4
1423	7.0900	38.3200	1755.00	977560.6
1424	7.0600	38.2900	1686.00	977570.8
1425	7.0600	38.2800	1680.00	977570.6
1426	7.0800	38.2700	1680.00	977573.4
1427	7.0800	38.2600	1680.00	977575.4
1428	7.0800	38.2600	1680.00	977583.2
1429	7.0700	38.2600	1680.00	977584.4
1430	7.0500	38.2600	1680.00	977574.4
1431	7.0300	38.2800	1680.00	977564.9
1432	7.0000	38.2700	1682.00	977565.2
1433	7.0300	38.2800	1685.00	977564.2
1434	7.0200	38.2800	1855.00	977531.6
1435	7.0300	38.2900	1690.00	977563.7
1436	7.0900	38.3100	1748.00	977562.4
1437	7.0100	38.2900	1738.00	977546.4
1438	7.1200	38.3600	1888.00	977523.6
1439	7.1200	38.2800	1800.00	977563.6
1440	7.1500	38.3100	1745.00	977569.2
1441	7.1300	38.0400	1790.00	977566.1
1442	7.0900	38.0300	1930.00	977539.8
1443	7.0900	37.5800	1960.00	977533.8
1444	7.0400	37.5600	1870.00	977551.7
1445	7.1300	38.3600	1880.00	977522.2
1446	7.1000	38.4000	2080.00	977477.2
1447	7.0900	38.4100	2275.00	977437.4
1448	7.1195	38.6614	2320.00	977430.3
1449	7.1190	38.6438	2430.00	977413.9
1450	7.1261	38.6757	2348.00	977420.8
1451	7.1167	38.5924	1840.00	977548.4
1452	7.1153	38.5706	2060.00	977510.4
1453	7.1264	37.9503	1950.00	977533.8
1454	7.0471	37.9248	1845.00	977551.7
1455	6.9651	37.8681	1985.00	977520.4
1456	6.9108	37.8158	2175.00	977482.9
1457	6.8587	37.7602	2035.00	977519.0
1458	7.0534	38.8068	2654.80	977338.9
1459	7.0756	38.7754	2649.50	977344.2
1460	7.1033	38.7432	2552.60	977369.9
1461	7.1277	38.7173	2473.00	977393.0
1462	7.0888	38.4812	1688.00	977570.8
1463	7.1223	38.4598	1680.00	977573.4
1464	7.1112	38.4221	1680.00	977575.4
1465	7.0471	38.4584	1680.00	977565.0

1466	7.0340	38.4668	1822.00	977531.6
1467	7.0036	38.5002	1715.00	977552.4
1468	6.9470	38.4743	1875.00	977524.4
1469	6.9017	38.4380	1900.00	977518.3
1470	6.8496	38.3869	1810.00	977541.1
1471	6.7681	38.3767	1735.00	977555.6
1472	7.1340	38.5055	1709.00	977564.1
1473	7.1021	38.4860	1693.00	977568.7
1474	7.0346	38.4666	1820.00	977531.6
1475	7.1178	38.7268	2500.00	977381.9
1476	7.0956	38.7532	2565.00	977363.0
1477	7.1282	38.5892	1940.50	977521.8
1478	7.1191	38.5842	1940.50	977521.7
1479	7.1014	38.5879	1982.30	977503.7
1480	7.1028	38.5970	1780.90	977552.1
1481	7.0938	38.6022	1711.50	977564.2
1482	7.0842	38.6133	1723.10	977558.3
1483	7.0611	38.6142	1733.70	977557.1
1484	7.0806	38.6351	1867.60	977529.1
1485	7.0901	38.6401	1867.90	977529.8
1486	7.0910	38.6328	1828.80	977539.5
1487	7.0956	38.6374	1895.80	977525.0
1488	7.0974	38.6144	1731.10	977561.2
1489	7.1087	38.6129	1758.10	977562.7
1490	7.1196	38.6010	1835.70	977547.3
1491	7.0059	39.3999	2395.00	977384.7
1492	7.0693	39.4008	2355.00	977400.2
1493	7.1218	39.3940	2310.00	977406.9
1494	7.0349	38.8445	2611.00	977343.1
1495	7.0240	38.9380	2570.00	977353.3
1496	7.0113	39.0139	2550.00	977352.3
1497	7.0014	39.1010	2460.00	977362.0
1498	6.9751	39.1828	2455.00	977366.3
1499	7.0161	39.2623	2400.00	977377.9
1500	6.9986	39.3381	2355.00	977394.3
1501	7.0756	38.7761	2645.00	977344.6
1502	7.0933	38.7965	2678.00	977339.3
1503	7.1176	38.8081	2662.00	977339.5
1504	7.1327	38.8330	2665.00	977337.7
1505	7.1495	39.2134	2383.00	977386.0
1506	7.1069	39.1978	2355.00	977388.5
1507	7.0736	39.1801	2378.00	977483.5
1508	7.0328	39.1599	2375.00	977381.2
1509	7.0014	39.1013	2460.00	977369.4
1510	7.0057	39.0529	2490.00	977361.4
1511	7.0127	39.0089	2546.00	977353.2
1512	7.0303	38.9689	2575.00	977348.1
1513	7.0258	38.9208	2578.00	977355.0
1514	7.0195	38.8762	2583.00	977359.9

1515	7.0401	38.8365	2626.00	977344.7
1516	7.0616	38.7970	2656.00	977338.4
1517	7.1499	38.6960	2346.50	977416.7
1518	7.1345	38.7109	2443.50	977398.2
1519	7.1178	38.7273	2503.50	977379.7
1520	7.1024	38.7436	2554.50	977363.1
1521	7.0865	38.7616	2627.50	977347.2
1522	7.0756	38.7854	2676.50	977338.7
1523	6.1182	38.2019	1870.00	977533.0
1524	6.1907	38.2232	1950.00	977514.6
1525	6.2745	38.2041	2005.00	977506.7
1526	6.3152	38.2564	1780.00	977554.1
1527	6.3469	38.2859	1580.00	977593.7
1528	6.4035	38.3119	1570.00	977590.3
1529	6.4692	38.3392	1790.00	977539.6
1530	6.5032	38.3903	1840.00	977529.0
1531	6.5584	38.3917	1885.00	977520.3
1532	6.6911	38.3585	1805.00	977536.3
1533	6.6626	38.3926	1785.00	977535.6
1534	6.6402	38.3994	1780.00	977538.7
1535	6.5892	38.4039	2000.00	977491.4
1536	6.5722	38.4426	2180.00	977453.8
1537	6.5485	38.4607	2370.00	977412.6
1538	6.5247	38.4857	2695.00	977347.6
1539	6.4896	38.5141	2745.00	977332.9
1540	6.4749	38.5356	2740.00	977336.9
1541	6.7908	37.7477	1810.00	977558.4
1542	6.7115	37.7704	1605.00	977615.1
1543	6.6504	37.8136	1410.00	977652.9
1544	6.5824	37.8181	1315.00	977677.2
1545	6.5190	37.7795	1265.00	977690.5
1546	6.4339	37.7477	1275.00	977679.2
1547	6.3514	37.7488	1360.00	977664.5
1548	6.2767	37.7841	1280.00	977684.9
1549	6.2189	37.7114	1365.00	977661.6
1550	6.1635	37.6683	1255.00	977674.9
1551	6.1205	37.6251	1255.00	977680.9
1552	6.0616	37.5956	1255.00	977670.7
1553	6.0344	37.5683	1300.00	977673.3
1554	7.0667	37.9333	1840.00	977551.6
1555	7.1500	37.9667	1935.00	977533.8
1556	7.0333	38.9167	2580.00	977353.2
1557	7.0500	38.4667	1685.00	977565.2
1558	7.0500	38.8333	2645.00	977343.0
1559	7.0833	38.7667	2655.00	977345.6
1560	7.1500	38.0500	1915.00	977539.7
1561	7.1500	38.6833	2325.00	977430.5
1562	7.0167	38.0000	2530.00	977352.2
1563	7.0667	39.3833	2340.00	977400.1

1564	7.1167	39.3833	2285.00	977406.9
1565	7.1333	39.3167	2320.00	977395.7
1566	7.0000	39.0500	1750.00	977527.7
1567	6.0500	37.6167	1425.00	977634.3
1568	6.0667	37.6333	1300.00	977673.5
1569	6.1000	37.7000	1255.00	977670.9
1570	6.1500	37.7500	1255.00	977681.1
1571	6.2333	37.8000	1255.00	977675.0
1572	6.3000	37.8167	1365.00	977661.8
1573	6.3833	37.8167	1280.00	977685.0
1574	6.4667	37.8167	1360.00	977664.7
1575	6.5333	37.8667	1275.00	977679.3
1576	6.6000	37.9000	1265.00	977690.7
1577	6.6500	37.9500	1315.00	977677.4
1578	6.7500	37.9167	1410.00	977653.0
1579	6.8000	37.8833	1605.00	977615.0
1580	6.8500	37.8167	1810.00	977558.3
1581	6.8667	37.7500	2035.00	977518.9
1582	6.9333	37.8333	2175.00	977482.8
1583	6.9833	37.8833	1965.00	977520.3
1584	6.0667	38.1833	1940.00	977519.7
1585	6.1333	38.2167	1870.00	977533.0
1586	6.2000	38.2167	1950.00	977514.5
1587	6.2667	38.2167	2005.00	977506.6
1588	6.3000	38.2500	1780.00	977554.1
1589	6.3667	38.2833	1580.00	977593.9
1590	6.4000	38.3000	1570.00	977590.6
1591	6.4667	38.3333	1790.00	977539.8
1592	6.5333	38.3833	1840.00	977529.1
1593	6.5833	38.4000	1885.00	977520.4
1594	6.6167	38.3667	1790.00	977537.3
1595	6.9667	39.1667	2450.00	977366.2
1596	6.0000	39.0667	2455.00	977341.7
1597	6.0000	39.2500	2405.00	977357.5
1598	6.0000	39.3000	2345.00	977374.0
1599	6.0000	39.3833	2395.00	977364.3
1600	5.0333	37.8167	1020.00	977728.7
1601	5.0833	37.7667	940.00	977745.9
1602	5.1167	37.7167	925.00	977757.3
1603	5.1500	37.6500	910.00	977777.7
1604	5.1833	37.5833	980.00	977773.9
1605	5.2167	37.5667	1285.00	977709.3
1606	5.2667	37.5500	1495.00	977669.8
1607	5.3000	37.5667	1370.00	977703.2
1608	5.3667	37.5167	1280.00	977701.5
1609	5.4500	37.4667	1340.00	977675.9
1610	5.5167	37.4500	1600.00	977615.3
1611	5.5500	37.4333	1835.00	977562.7
1612	5.6833	37.4667	1560.00	977613.4

1613	5.7000	37.4833	1460.00	977635.7
1614	5.7667	37.5000	1255.00	977679.7
1615	5.8500	37.5333	1185.00	977687.8
1616	5.9333	37.5500	1205.00	977680.2
1617	5.9833	37.5833	1185.00	977676.6
1618	5.1333	38.2000	1665.00	977587.4
1619	5.2167	38.2167	1615.00	977599.6
1620	5.2833	38.2500	1595.00	977610.8
1621	5.3667	38.2833	1610.00	977603.2
1622	5.4333	38.2833	1690.00	977577.3
1623	5.4500	38.2833	1710.00	977572.2
1624	5.5167	38.2667	1935.00	977526.0
1625	5.5667	38.2500	1935.00	977528.4
1626	5.6333	38.2500	1895.00	977534.7
1627	5.7000	38.2167	1700.00	977580.4
1628	5.7167	38.2000	1980.00	977519.9
1629	5.7500	38.2000	2225.00	977461.0
1630	5.7833	38.2000	2040.00	977500.4
1631	5.8833	38.2167	1690.00	977569.9
1632	5.9667	38.2000	1690.00	977572.0
1633	4.9333	37.9667	1480.00	977636.4
1634	4.9500	37.9167	1270.00	977682.3
1635	4.0000	37.8667	1115.00	977699.6
1636	4.9333	37.0000	1570.00	977614.9
1637	4.9167	38.0333	1765.00	977570.1
1638	7.0667	37.9333	1870.00	977551.7
1639	7.1500	37.9667	1960.00	977533.7
1640	7.0167	38.4833	1738.00	977546.5
1641	7.0333	38.4667	1815.00	977531.7
1642	7.0500	38.4667	1680.00	977565.1
1643	7.0500	38.4667	1685.00	977564.3
1644	7.0500	38.4833	1690.00	977563.9
1645	7.0833	38.4333	1680.00	977574.6
1646	7.0833	38.7667	2650.00	977344.1
1647	7.1000	38.4667	1680.00	977570.7
1648	7.1000	38.4833	1686.00	977571.0
1649	7.1000	38.7500	2560.00	977365.5
1650	7.1167	38.4333	1680.00	977584.5
1651	7.1333	38.4333	1680.00	977583.4
1652	7.1333	38.4500	1680.00	977573.6
1653	7.1500	38.0500	1930.00	977539.8
1654	7.1500	38.5167	1747.50	977562.6
1655	7.1500	38.5333	1755.00	977560.7
1656	7.1500	38.6833	2275.00	977437.4
1657	6.9833	37.8833	2000.00	977520.3
1658	6.5000	38.5167	2740.00	977336.8
1659	6.5167	38.5000	2745.00	977332.8
1660	6.5333	38.4667	2695.00	977347.5
1661	6.6000	38.4500	2370.00	977412.6

1662	6.6167	38.3667	1780.00	977538.9
1663	6.6167	38.4167	2000.00	977491.3
1664	6.6167	38.4333	2180.00	977453.7
1665	6.6333	38.3500	1785.00	977535.8
1666	6.7000	38.3333	1805.00	977536.5
1667	6.7667	38.3333	1725.00	977555.8
1668	6.8333	38.3667	1800.00	977541.2
1669	6.9000	38.4167	1885.00	977518.4
1670	6.9500	38.4667	1865.00	977524.6
1671	6.0000	38.4500	1682.00	977545.1
1672	6.0000	38.5000	1705.00	977532.3
1673	5.7833	36.5500	1311.00	977687.6
1674	5.2833	39.6833	1478.00	977610.1
1675	4.8000	35.9667	381.00	977911.1
1676	4.8000	35.9833	381.00	977911.0
1677	4.0667	38.4833	2164.00	977614.7
1678	7.0780	38.8080	2678.00	977339.8
1679	7.0930	38.7820	2653.00	977348.2
1680	7.1090	38.7640	2572.00	977364.2
1681	7.1300	38.7400	2520.00	977380.9
1682	7.1470	38.7250	2450.00	977399.3
1683	7.1500	37.9667	1935.00	977517.1
1684	7.0667	37.9333	1840.00	977534.9
1685	7.1500	38.5333	1755.00	977543.9
1686	7.1000	38.4833	1686.00	977554.1
1687	7.1000	38.4667	1680.00	977553.8
1688	7.1333	38.4500	1680.00	977556.7
1689	7.1333	38.4333	1680.00	977558.7
1690	7.1167	38.4333	1680.00	977567.6
1691	7.0833	38.4333	1680.00	977557.7
1692	7.0500	38.4667	1680.00	977548.2
1693	7.0500	38.4667	1685.00	977547.5
1694	7.0333	38.4667	1815.00	977514.8
1695	7.0500	38.4833	1690.00	977547.0
1696	7.1500	38.5167	1748.00	977545.8
1697	7.0167	38.4833	1738.00	977529.6
1698	7.0167	38.4833	1738.00	977529.6
1699	7.1500	38.0500	1915.00	977523.0
1700	7.1500	38.6833	2275.00	977420.7
1701	7.1000	38.7500	2560.00	977348.8
1702	7.0833	38.7667	2655.00	977328.8
1703	7.0500	38.4667	1685.00	977548.4
1704	7.0500	38.8333	2654.00	977326.4
1705	7.0333	38.9167	2580.00	977336.5
1706	7.0167	38.0000	2530.00	977335.6
1707	7.0667	39.3833	2340.00	977383.4
1708	7.1167	39.3833	2285.00	977390.2
1709	7.1167	39.3833	2285.00	977390.2
1710	7.1333	39.3167	2320.00	977378.9

1711	7.0000	39.0500	1750.00	977510.8
1712	6.9833	37.8833	1965.00	977503.6
1713	6.9333	37.8333	2175.00	977466.1
1714	6.8667	37.7500	2035.00	977502.2
1715	6.8500	37.8167	1810.00	977541.7
1716	6.8000	37.8833	1605.00	977598.4
1717	6.7500	37.9167	1410.00	977636.2
1718	6.6500	37.9500	1315.00	977660.5
1719	6.6000	37.9000	1265.00	977673.8
1720	6.5333	37.8667	1275.00	977662.6
1721	6.4666	37.8166	1360.00	977647.9
1722	6.3833	37.8166	1280.00	977668.2
1723	6.3000	37.8166	1365.00	977644.9
1724	6.2333	37.8000	1255.00	977658.3
1725	6.1500	37.7500	1255.00	977664.3
1726	6.1000	37.7000	1255.00	977654.0
1727	6.0667	37.6333	1300.00	977656.7
1728	6.0500	37.6167	1425.00	977617.4
1729	6.0000	38.4500	1682.00	977528.2
1730	6.0000	38.5000	1705.00	977515.4
1731	6.9500	38.4667	1865.00	977507.7
1732	6.9000	38.4167	1885.00	977501.5
1733	6.8333	38.3667	1800.00	977524.3
1734	6.7667	38.3333	1725.00	977538.9
1735	6.7000	38.3333	1805.00	977519.6
1736	6.6333	38.3500	1785.00	977518.9
1737	6.6167	38.3667	1790.00	977520.6
1738	6.6167	38.4167	2000.00	977474.7
1739	6.6167	38.4333	2180.00	977437.0
1740	6.6000	38.4500	2370.00	977395.8
1741	6.5333	38.4667	2695.00	977330.9
1742	6.5167	38.5000	2745.00	977316.2
1743	6.5000	38.5167	2740.00	977320.1
1744	6.0667	38.1833	1940.00	977503.0
1745	6.1333	38.2167	1870.00	977516.3
1746	6.2000	38.2167	1950.00	977497.9
1747	6.2667	38.2167	2005.00	977490.0
1748	6.3000	38.2500	1780.00	977537.4
1749	6.3667	38.2833	1580.00	977576.9
1750	6.4000	38.3000	1570.00	977573.6
1751	6.4667	38.3333	1790.00	977522.9
1752	6.5333	38.3833	1840.00	977512.2
1753	6.5833	38.4000	1885.00	977503.6
1754	6.0000	39.0667	2455.00	977325.0
1755	6.9667	39.1667	2450.00	977349.6
1756	6.0000	39.2500	2405.00	977340.8
1757	6.0000	39.3000	2345.00	977357.3
1758	6.0000	39.3833	2395.00	977347.7
1759	5.9833	37.5833	1185.00	977659.7

1760	5.9333	37.5500	1205.00	977663.3
1761	5.8500	37.5333	1185.00	977671.0
1762	5.7667	37.5000	1255.00	977662.9
1763	5.7000	37.4833	1460.00	977619.0
1764	5.6833	37.4667	1560.00	977596.7
1765	5.5500	37.4333	1835.00	977546.0
1766	5.5167	37.4500	1600.00	977598.6
1767	5.4500	37.4667	1340.00	977659.3
1768	5.3667	37.5167	1280.00	977684.9
1769	5.3000	37.5667	1370.00	977686.6
1770	5.2667	37.5500	1495.00	977653.2
1771	5.2167	37.5667	1285.00	977692.7
1772	5.1833	37.5833	980.00	977757.2
1773	5.1500	37.6500	910.00	977760.9
1774	5.1167	37.7167	925.00	977740.5
1775	5.0833	37.7667	940.00	977729.1
1776	5.0333	37.8167	1020.00	977711.9
1777	5.0500	38.2000	1670.00	977570.9
1778	5.1333	38.2000	1665.00	977570.7
1779	5.2167	38.2167	1615.00	977583.0
1780	5.2833	38.2500	1595.00	977594.1
1781	5.3667	38.2833	1610.00	977586.5
1782	5.4333	38.2833	1690.00	977560.6
1783	5.4500	38.2833	1710.00	977555.5
1784	5.5167	38.2667	1935.00	977509.3
1785	5.5667	38.2500	1935.00	977511.7
1786	5.6333	38.2500	1895.00	977518.0
1787	5.7000	38.2167	1700.00	977563.6
1788	5.7167	38.2000	1980.00	977503.1
1789	5.7500	38.2000	2225.00	977444.3
1790	5.7833	38.2000	2040.00	977483.7
1791	5.8833	38.2167	1690.00	977553.1
1792	5.9667	38.2000	1690.00	977555.3
1793	4.0000	37.8667	1115.00	977682.8
1794	4.9500	37.9167	1270.00	977665.7
1795	4.9333	37.9667	1480.00	977619.7
1796	4.9333	37.0000	1570.00	977598.3
1797	4.9167	38.0333	1765.00	977553.4
1798	4.8833	38.1000	1770.00	977551.2
1799	4.9000	38.1833	1610.00	977583.9
1800	4.9667	38.2000	1545.00	977599.2

PRESENTED BY
ESTIFANOS ASRAT