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DEPARTMENT OF NATURAL RESOURCES

DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

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GRAVITY SURVEY OF THE LOWER SUSITNA BASIN

By
Eugene Wescott and William Witte

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By

Eugene Wescott and William Witte
Geophysical Institute
University of Alaska

ABSTRACT

In summer 1981 a detailed gravity survey of part of the lower Susitna basin was carried out in support of a geothermal reconnaissance survey with a station spacing of about one per square mile. The resultant data were combined with other data to produce a simple Bouguer anomaly map. The regional effect of the Castle Mountain fault was removed from the detailed contour map area to produce a residual map. Two basement ridges separated by a depression are evident in the residual map. A profile crossing these basement features has been modelled to produce a cross section.

GRAVITY SURVEY

The Tertiary and Quaternary sedimentary section of the lower Susitna basin north of the Castle Mountain fault increases in thickness from essentially zero at the basin margins to about 2,000 ft in the area of the Red Shirt Lake well and probably deepens to the west in the center of the basin. On the basis of scattered well data, most of the basin in the study area is believed to be underlain by granitic basement. In a basin of low-density sediments underlain by a higher-density granitic basement, a gravity map of the area can be converted into a map showing approximate variations in thickness of the sedimentary section. Although the upper surface of the sediments in the valley is essentially flat, the thickness of the section may vary considerably because of deposition over old, buried topography in the granitic basement.

South of the Castle Mountain fault the sedimentary section is at least 12,000 ft thick. The gravity anomaly associated with this high-angle reverse fault is evident in the data. Plate 1 is a gravity map based on data from our 1981 survey (table 1) and some data from Barnes (1976 and pers. commun., 1981) and from Thiel and others (1958).

The area was surveyed with a Worden-491 gravimeter, which has a battery-operated thermostatic temperature-control unit. Altitudes were determined from various sources. Benchmarks with known surveyed altitudes were occupied wherever possible. Within the Nancy Lake Recreation Area, we used a 1:7,200-scale contour map with 6-ft contour intervals and occupied stations where locations could be determined from the maps. In the rest of the area we located stations on a 1:63,360-scale map and used a pair of Paulin altimeters for altitude control, referenced to a base station at the Nancy Lake Recreation Area headquarters building. The mean estimated incertainty in station elevation is 5.0 ft. Our net of stations was tied to previous gravity surveys by taking readings at the gravity station at the Talkeetna Motel (TAMO) and at BMV105, 1965 (241 ft), at the intersection of the railroad and the Parks

Highway near the Talkeetna cutoff. Although the altitude accuracy varied with different stations, very little smoothing was required to produce the 1 milligal contour map (pl. 1).

Two gravity highs (H, pl. 1) are interpreted as representing N-S-trending basement ridges separated by a broad basement valley. The regional anomaly due to the large vertical offset of the Castle Mountain fault was removed from the data by using a two-dimensional model. A high-angle reverse fault dipping at 60° with a density contrast of 0.375 was found to give reasonable fit to the data from about 4 miles SSW of the fault to 12 miles NNW of it. A vertical offset of 10,150 ft was assumed for the fault. Plate 2 shows the contour map with the residual gravity anomalies.

The main features remain: two high ridges in the basement separated by a depression. Although we did not have enough time to extend the detailed gravity coverage to the west, a few data points indicate that the basin becomes deeper towards the Susitna River. To convert the residual Bouguer anomaly map (pl. 2) to estimated sedimentary-section thicknesses, we used a two-dimensional polygonal modelling program of the Talwani type (Campbell, 1981).

The residual anomaly map is based on the Bouguer correction to sea level using 2.67 as the density. We know this is in fact too high because most of the survey area is underlain by a thick sedimentary section with lower density. On plate 2, cross section A-A', which contains the control point Red Shirt Lake 1, cuts across the two gravity ridges that are separated by a depression. We used a density of 2.32 to calculate correction factors for the profile A-A' shown in figure 1. We assumed a granodiorite density of 2.716 (Clark, 1966), which also agreed with densities of several hand samples we collected. The gravity profiles for two different density values of 2.32 and 2.12 were calculated as shown in figure 1; the estimated depth to the top of the eastern basement ridge varied between 57 and 535 ft respectively, for these densities. A density of 2.12 g/cc was chosen as a probable lower limit for the sediments in the model calculation.

We think these are reasonable density limits. The estimated sediment thickness in the depression between the ridges ranged between 1,210 ft and 1,485 ft. We used the actual values along the profile for the sediment-thickness calculations. Smoothing and using an average value for the profile would change these thickness values somewhat.

By extension, the gravity high west of Willow is estimated to be underlain by granodiorite at a depth between 50 and 500 ft. A water well at the Willow Tesoro station (pl. 2) was drilled to a depth of 172 ft near the -58 mgal contour, implying basement depth greater than 172 ft.

ACKNOWLEDGMENTS

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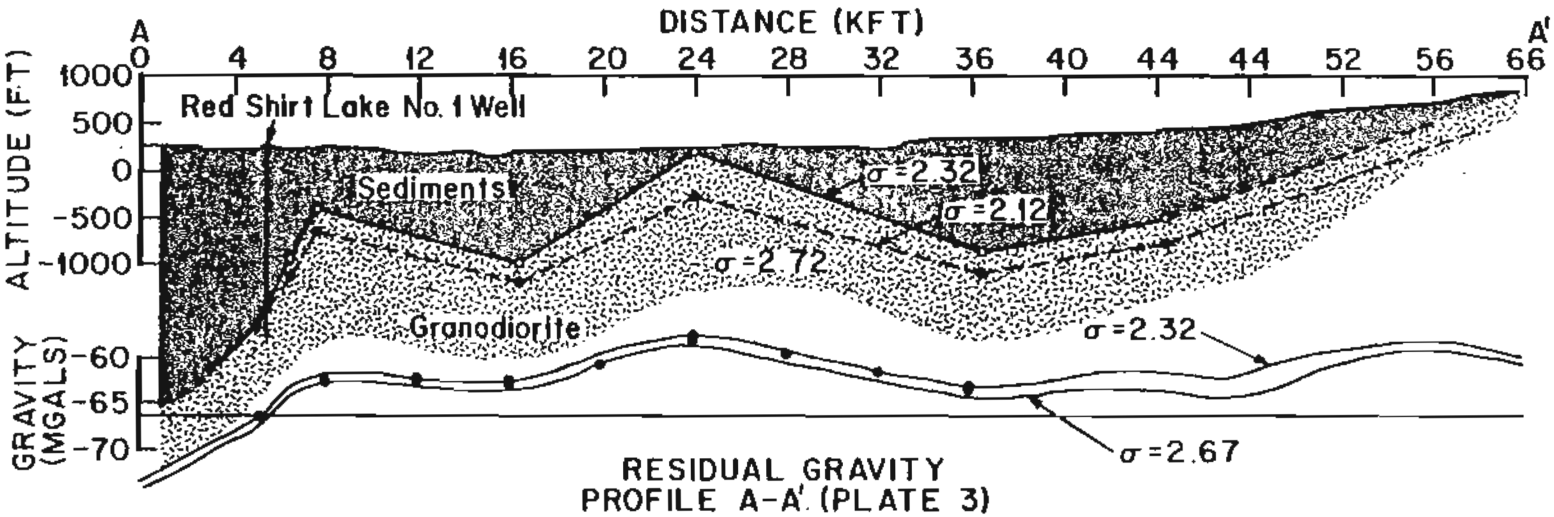

Figure 1. Gravity model for cross section A-A' (pl. 2). Lower part shows gravity data for Bouguer corrections of σ = 2.32 and 2.67. Upper solid and dashed lines define sedimentary-section depth limits for sediment densities of 2.32 and 2.12, respectively.

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TABLE 1. Gravity Data

Station	Longitude	Latitude	Altitude (ft.)	SBA (milligals)
BASE	150° 01.90'	61° 41.75'	270	-67.94
TAMO	150° 06.95'	62° 19.37'	340	-70.02
BM 347	150° 04.80'	62° 09.00'	345.386	-69.06
WIW-1	150° 01.20'	61° 42.70'	278	-65.84
WIW-2	150° 02.00'	61° 42.15'	255	-65.93
WIW-3	150° 01.90'	61° 41.95'	229	-67.33
WIW-4	150° 02.00'	61° 41.10'	284	-66.15
WIW-5	150° 03.25'	61° 40.70'	280	-65.88
WIW-6	150° 04.20'	61° 40.65'	252	-65.94
WIW-7	150° 05.35'	61° 40.60'	219	-67.28
WIW-8	150° 06.45'	61° 40.40'	224	-72.53
WIW-9	150° 08.20'	61° 40.05'	190	-69.41
BM 251	149° 59.90'	61° 42.15'	250.249	-67.73
WIW-11	149° 01.05'	61° 30.20'	241	-85.33
BM 242	149° 55.90'	61° 39.45'	242	-76.06
BM S103	149° 52.40'	61° 38.90'	307.02	-82.24
BM 228 (Willow Station)	150° 02.25'	61° 44.65'	228	-61.42
WG-1	150° 03.60'	61° 42.25'	299	-64.69
WG-2	150° 04.50'	61° 42.55'	267	-62.77
WG-3	150° 04.80'	61° 42.25'	192	-63.69
WG-4	150° 02.75'	61° 42.70'	226	-63.74
WG-5	150° 06.85'	61° 42.90'	209	-64.16
WG-6	150° 05.40'	61° 43.20'	191	-61.60
WG-7	150° 05.30'	61° 44.25'	220	-60.52
WG-8	150° 06.60'	61° 44.90'	188	-62.16
WG-9	150° 07.20'	61° 44.25'	199	-63.29
WG-10	150° 07.35'	61° 43.60'	192	-64.28
WG-11	150° 07.80'	61° 43.15'	202	-65.06
WG-12	150° 06.75'	61° 42.10'	247	-65.14
WG-13	150° 05.35'	61° 41.45'	194	-64.54
WG-14	150° 04.95'	61° 43.85'	188.5	-60.50
WG-15	150° 04.00'	61° 44.85'	210	-59.98
WG-16	150° 03.30'	61° 44.30'	202	-60.45
WG-17	150° 03.80'	61° 43.80'	214	-60.46
WG-18	150° 00.00'	61° 41.45'	219	-67.90
WG-19	149° 59.50'	61° 40.95'	218	-68.07
WG-20	149° 59.20'	61° 41.85'	243	-68.95
WG-21	149° 58.50'	61° 41.10'	218	-68.67
WG-22	149° 57.80'	61° 40.45'	240	-68.89
WG-23	149° 59.00'	61° 40.30'	220	-67.94
WG-24	149° 59.65'	61° 39.50'	250	-69.87
WG-25	149° 55.20'	61° 46.00'	337	-63.27
WG-26	149° 55.70'	61° 45.05'	280	-64.64
WG-27	149° 55.00'	61° 45.50'	339	-64.59
WG-28	150° 03.95'	61° 46.00'	152	-57.41
WG-29	150° 03.60'	61° 45.40'	203	-58.63
WG-30	150° 05.00'	61° 45.65'	194	-58.44
WG-31	150° 03.10'	61° 44.65'	202	-60.30
WG-32	150° 02.30'	61° 43.30'	233	-60.64

Station	Longitude	Latitude	Altitude (ft.)	SBA (milligals)
WG-33	150° 02.00'	61° 43.55'	291	-63.36
WG-34	150° 05.70'	61° 38.50'	270	-76.56
WG-35	149° 55.80'	61° 40.80'	389	-70.82
WG-36	149° 56.00'	61° 40.15'	338	-74.40
WG-37	149° 44.05'	61° 40.40'	416	-73.32
WG-38	149° 44.30'	61° 41.10'	471	-66.87
WG-39	149° 42.20'	61° 41.15'	590	-72.70
WG-40	149° 58.20'	61° 42.10'	324	-69.36
WG-41	149° 56.00'	61° 42.00'	392	-69.14
WG-42	149° 54.20'	61° 41.90'	486	-67.58
WG-43	149° 52.50'	61° 42.05'	611	-66.06
WG-44	149° 50.60'	61° 42.00'	716	-63.21
WG-45 (VABM Bullion)	149° 47.10'	61° 43.05'	1500	-63.11
WG-46	149° 50.50'	61° 41.35'	709	-67.88
WG-47	149° 40.70'	61° 40.35'	514	-72.00
WG-48	149° 42.40'	61° 40.35'	455	-75.52
WG-49	149° 59.50'	61° 42.90'	281	-67.14
WG-50	149° 57.80'	61° 43.15'	307	-67.32
WG-51	149° 56.00'	61° 42.75'	373	-68.33
WG-52	149° 54.30'	61° 42.90'	477	-66.66
WG-53	149° 52.40'	61° 42.95'	525	-61.77
WG-54	149° 59.70'	61° 43.85'	287	-64.83
WG-55	149° 58.90'	61° 43.80'	310	-66.77
WG-56	149° 56.00'	61° 43.75'	348	-67.54
WG-57	149° 55.20'	61° 43.75'	406	-66.65
WG-58	149° 52.65'	61° 44.05'	450	-61.40
WG-59	149° 50.30'	61° 43.65'	870	-62.17
WG-60	149° 48.65'	61° 43.75'	1358	-62.42
WG-61	149° 46.50	61° 43.80'	1425	-62.25
WG-62	150° 00.75'	61° 39.25'	263	-69.18
WG-63	150° 01.40'	61° 39.35'	281	-70.32
WG-64	150° 05.50'	61° 39.90'	216	-68.96
WG-65	150° 06.20'	61° 38.10'	235	-80.08
WG-66	150° 06.15'	61° 38.90'	245	-74.70
WG-67	150° 07.33'	61° 39.37'	157	-71.98
WG-68	150° 09.40'	61° 39.00'	131	-74.01
WG-69	150° 11.60'	61° 36.00'	155	-87.42
WG-70	150° 10.30'	61° 34.75'	155	-96.49
WG-71	150° 16.30'	61° 33.95'	107	-101.73
WG-72	150° 09.10'	61° 35.05'	181	-96.65
WG-73	150° 04.35'	61° 37.55'	188	-78.11
WG-74	150° 03.40'	61° 40.05'	221	-68.49
WG-75	150° 05.05'	61° 38.55'	230	-71.15
WG-76	149° 50.90'	61° 42.95'	622	-62.58
WG-77	149° 48.80'	61° 42.90'	1184	-63.31
WG-78	149° 48.70'	61° 42.15'	992	-68.51
WG-79	149° 49.00'	61° 41.75'	842	-65.71
WG-80	149° 50.20'	61° 41.80'	720	-66.41
WG-81	149° 51.55'	61° 41.85'	626	-66.55
WG-82	149° 48.60'	61° 41.15'	853	-69.20

Station	Longitude	Latitude	Altitude (ft.)	SBA (milligals)
WG-83	149° 46.75'	61° 41.45'	954	-72.31
WG-84	150° 01.20'	61° 34.95'	179	-105.80
WG-85 (VABM FORK)	150° 23.75'	61° 34.87'	112	-102.12
WG-86	150° 16.80'	61° 38.20'	140	-87.53
WG-87	150° 01.40'	61° 40.45'	280	-66.06
WG-88	150° 04.00'	61° 39.25'	238	-69.76
WG-89	150° 05.20'	61° 39.30'	247	-71.78
WG-90	150° 06.90'	61° 38.40'	307	-78.21
WG-91	150° 06.80'	61° 41.20'	216	-67.30
WG-92	150° 03.05'	61° 41.50'	250	-65.32
WG-93	149° 55.20'	61° 35.45'	180	-107.15
WG-94	149° 59.65'	61° 44.65'	232	-64.71
WG-95	149° 57.70'	61° 44.80'	272	-65.73
WG-96	149° 57.80'	61° 45.35'	228	-65.05
WG-97	149° 59.40'	61° 45.40'	195	-63.80
WG-98	150° 01.60'	61° 48.25'	190	-57.04
WG-99	149° 54.15'	61° 45.45'	402	-63.04
WG-100	149° 52.30'	61° 45.45'	409	-62.48
WG-101	149° 48.80'	61° 46.40'	1231	-60.09
WG-102	149° 48.50'	61° 45.60'	1230	-62.28
WG-103	149° 49.65'	61° 45.10'	1070	-60.52
WG-104	149° 52.60'	61° 44.70'	449	-62.43
WG-105	149° 44.40'	61° 41.40'	780	-82.02
WG-106	149° 40.70'	61° 39.70'	580	-84.79
WG-107	149° 45.15'	61° 39.90'	566	-82.22
WG-108	149° 59.80'	61° 37.15'	200	-83.77
WG-109	149° 54.70'	61° 37.40'	213	-86.57
WG-110	150° 05.20'	61° 32.55'	140	-120.06
WG-111	150° 17.73'	61° 41.91'	62	-84.56
WG-112	150° 11.20'	61° 48.90'	96	-75.89