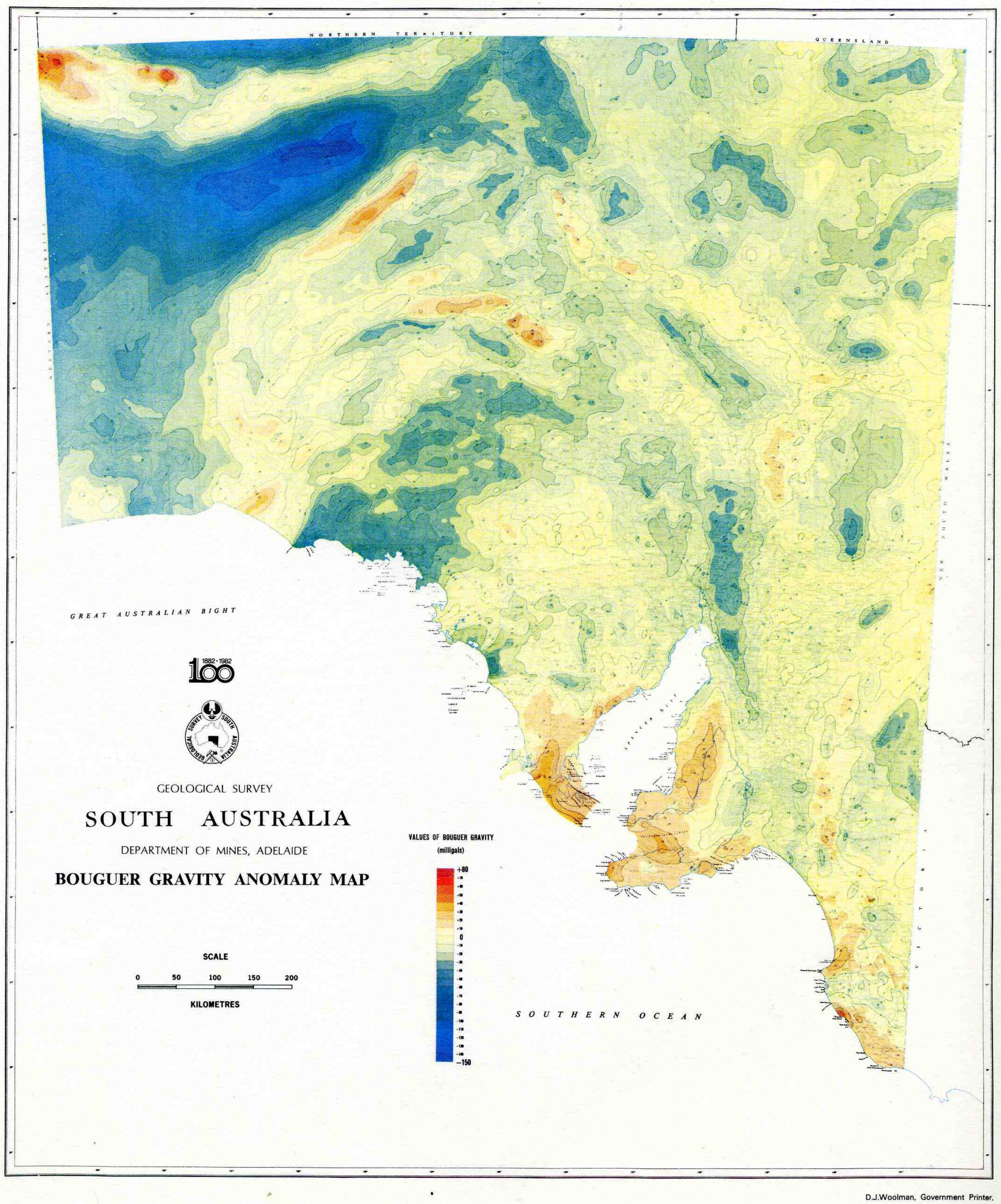
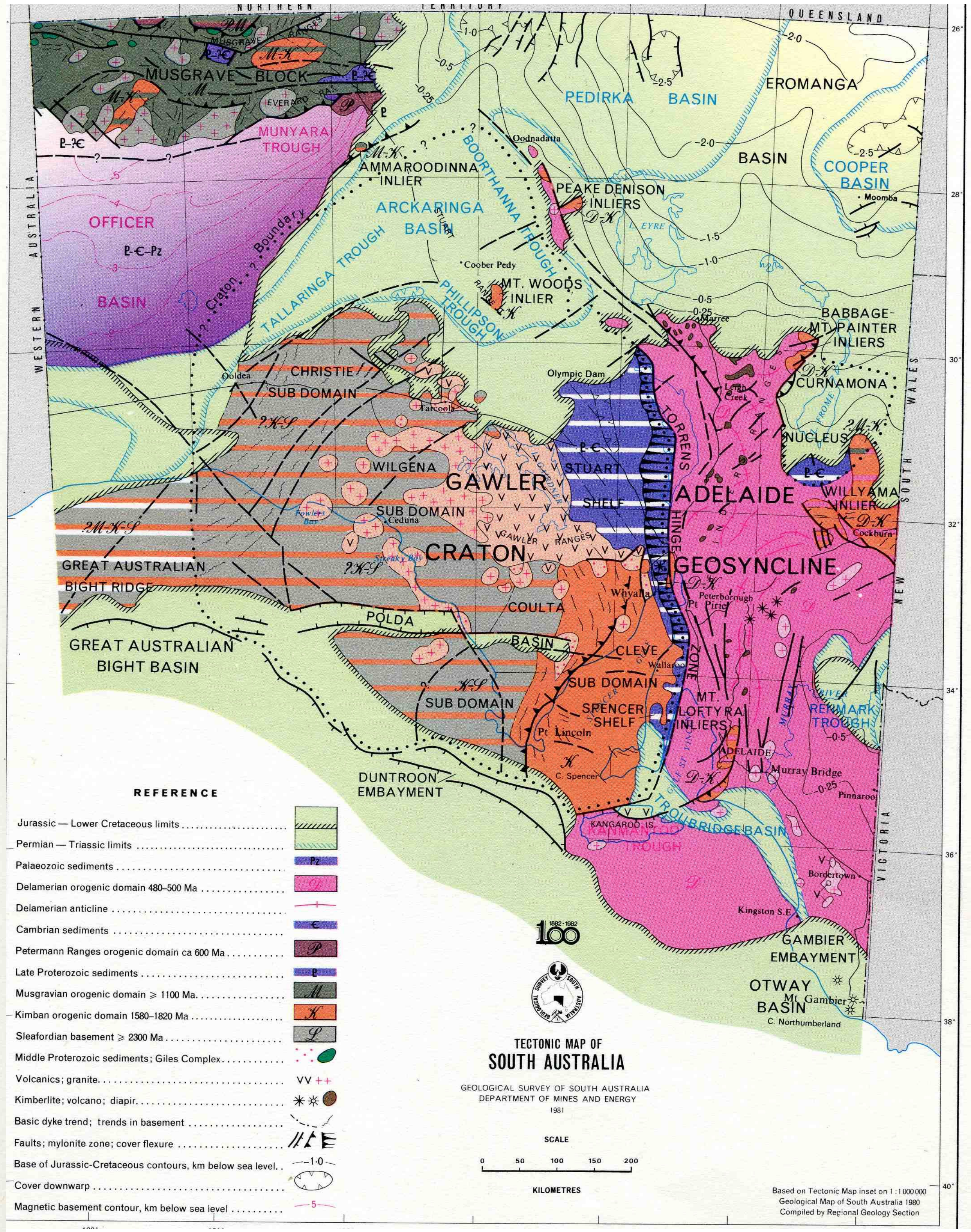
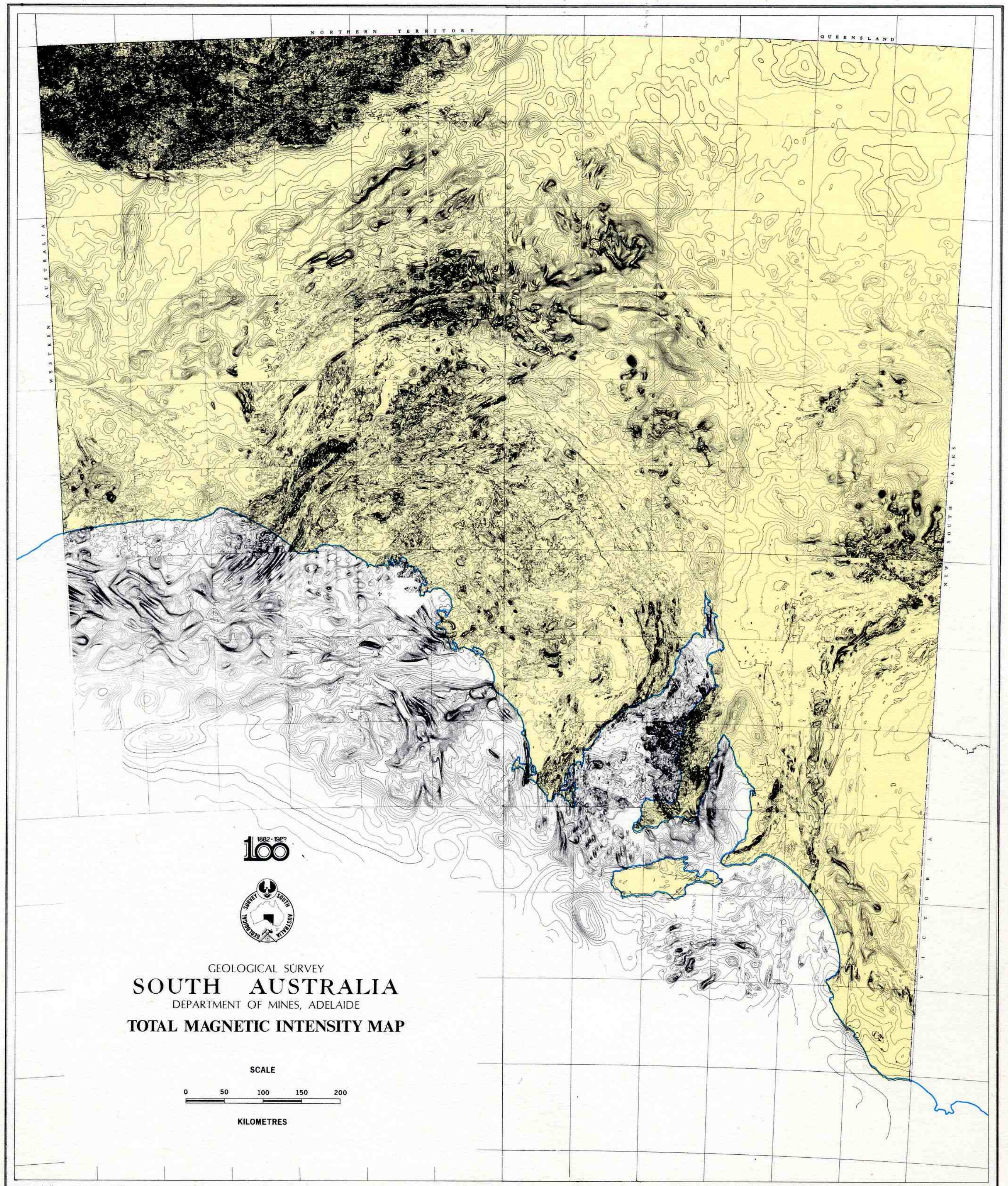
Magnetics

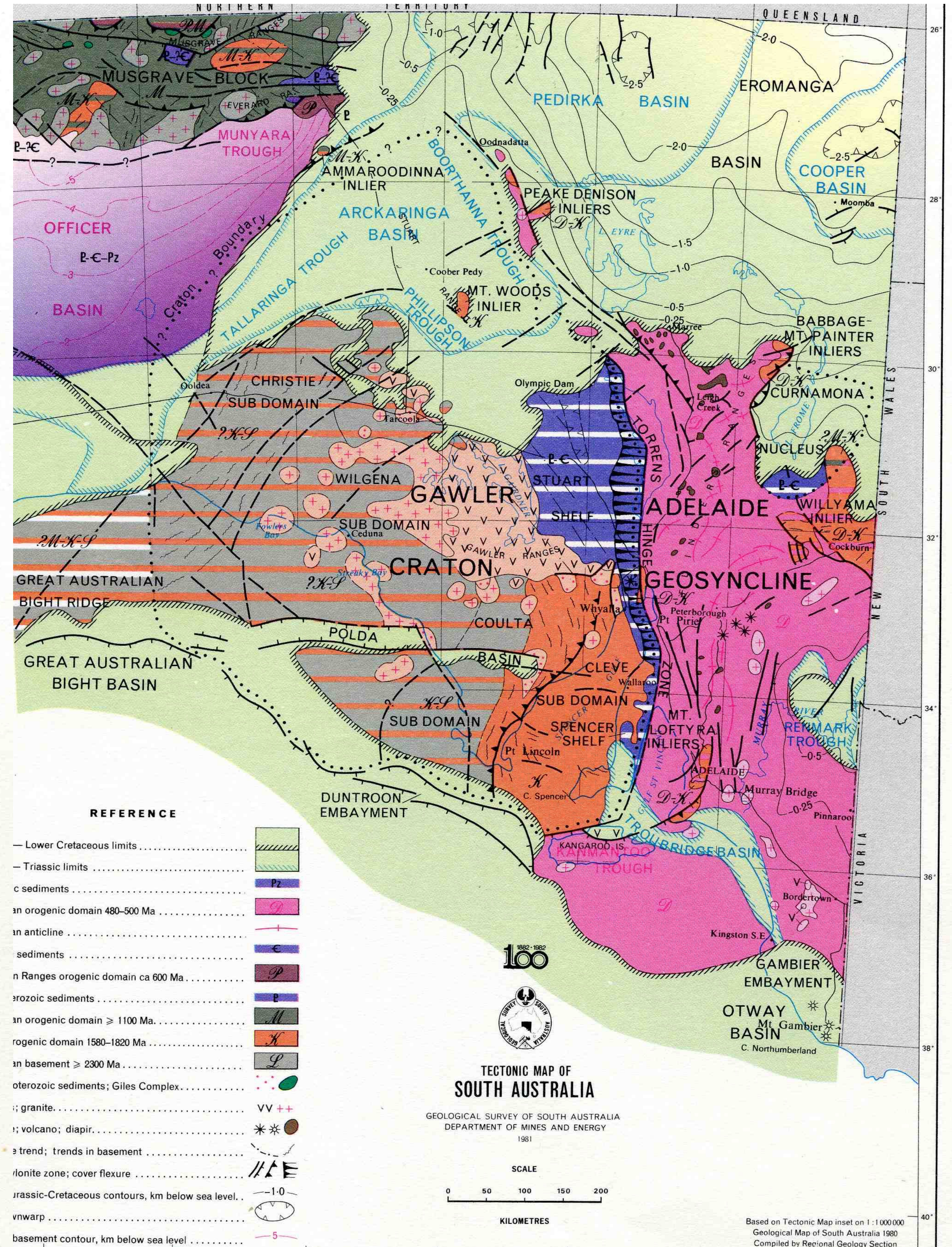

VH-BGE

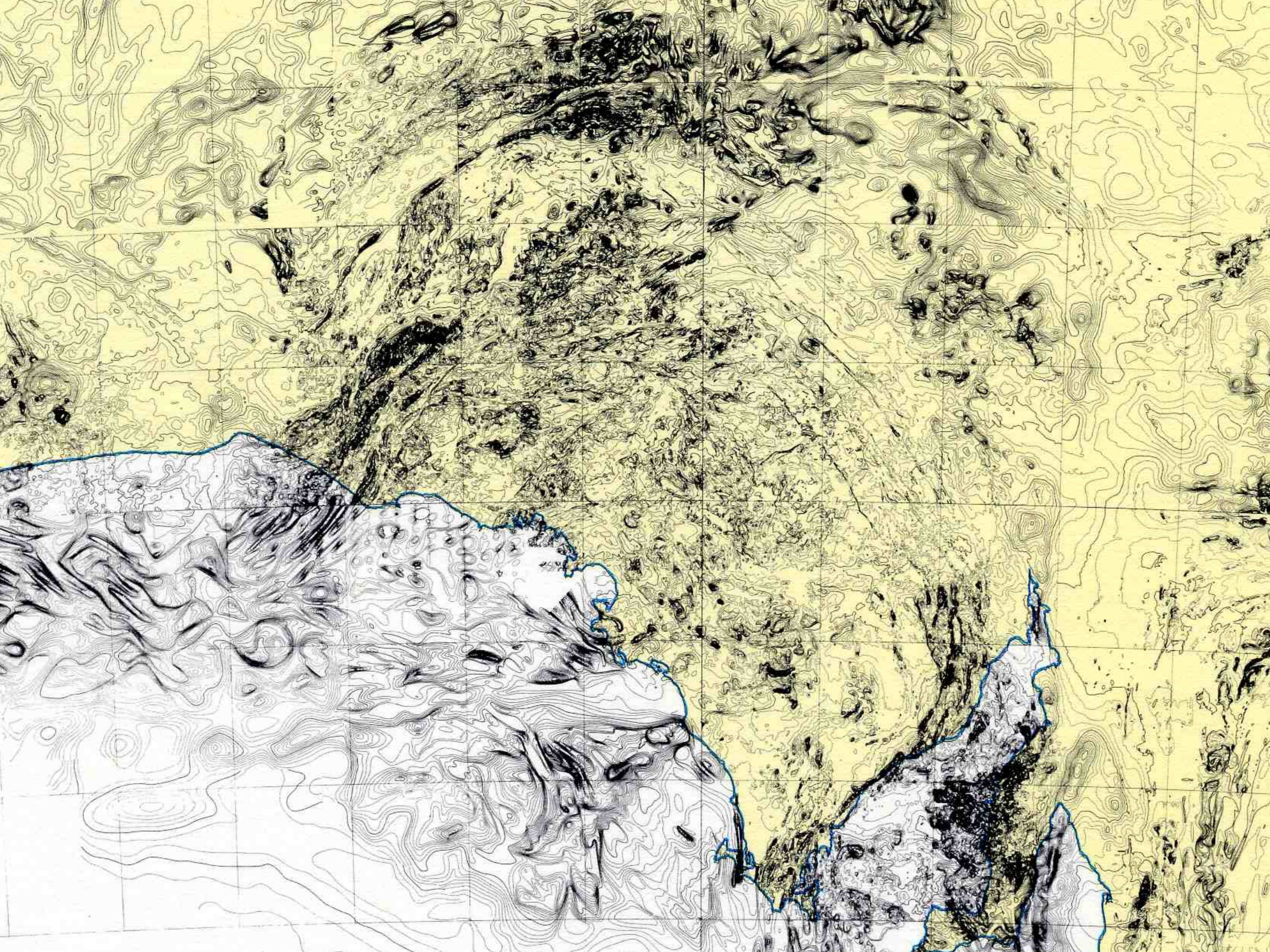

NORTHERN TERRITORY
QUEENSLAND
GREAT AUSTRALIAN BIGHT
SOUTHERN OCEAN
1882-1982
100
GEOLOGICAL SURVEY
SOUTH AUSTRALIA
DEPARTMENT OF MINES, ADELAIDE
BOUGUER GRAVITY ANOMALY MAP
VALUES OF BOUGUER GRAVITY
(milligals)
+80
0
−150
SCALE
0 50 100 150 200
KILOMETRES
D.J.Woolman, Government Printer.


NORTHERN
TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
NEW SOUTH WALES
VICTORIA
MUSGRAVE BLOCK
MUNYARA TROUGH
OFFICER
BASIN
Craton Boundary
AMMAROODINNA INLIER
BOORTHANNA TROUGH
ARCKARINGA BASIN
TALLARINGA TROUGH
PHILLIPSON TROUGH
PEDIRKA BASIN
EROMANGA
BASIN
COOPER BASIN
Moomba
Oodnadatta
PEAKE DENISON INLIERS
Coober Pedy
MT. WOODS INLIER
BABBAGE-MT. PAINTER INLIERS
CURNAMONA
NUCLEUS
WILLYAMA INLIER
Cockburn
Olympic Dam
Ooldea
Tarcoola
CHRISTIE SUB DOMAIN
WILGENA
GAWLER
SUB DOMAIN
Ceduna
CRATON
STUART SHELF
TORRENS HINGE ZONE
ADELAIDE
GEOSYNCLINE
GREAT AUSTRALIAN BIGHT RIDGE
GREAT AUSTRALIAN BIGHT BASIN
POLDA BASIN
COULTA
CLEVE SUB DOMAIN
SUB DOMAIN
Whyalla
Peterborough
Pt Pirie
Wallaroo
SPENCER SHELF
Pt Lincoln
C. Spencer
MT. LOFTY RA. INLIERS
ADELAIDE
Murray Bridge
Pinnaroo
RENMARK TROUGH
DUNTROON EMBAYMENT
KANGAROO IS.
KANMANTOO TROUGH
TROUBRIDGE BASIN
Bordertown
Kingston S.E.
GAMBIER EMBAYMENT
OTWAY BASIN
Mt. Gambier
C. Northumberland
REFERENCE
Jurassic — Lower Cretaceous limits
Permian — Triassic limits
Palaeozoic sediments
Delamerian orogenic domain 480–500 Ma
Delamerian anticline
Cambrian sediments
Petermann Ranges orogenic domain ca 600 Ma
Late Proterozoic sediments
Musgravian orogenic domain ≥ 1100 Ma
Kimban orogenic domain 1580–1820 Ma
Sleafordian basement ≥ 2300 Ma
Middle Proterozoic sediments; Giles Complex
Volcanics; granite
Kimberlite; volcano; diapir
Basic dyke trend; trends in basement
Faults; mylonite zone; cover flexure
Base of Jurassic-Cretaceous contours, km below sea level
Cover downwarp
Magnetic basement contour, km below sea level
1882-1982
100
TECTONIC MAP OF
SOUTH AUSTRALIA
GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES AND ENERGY
1981
SCALE
0 50 100 150 200
KILOMETRES
Based on Tectonic Map inset on 1 : 1 000 000
Geological Map of South Australia 1980
Compiled by Regional Geology Section



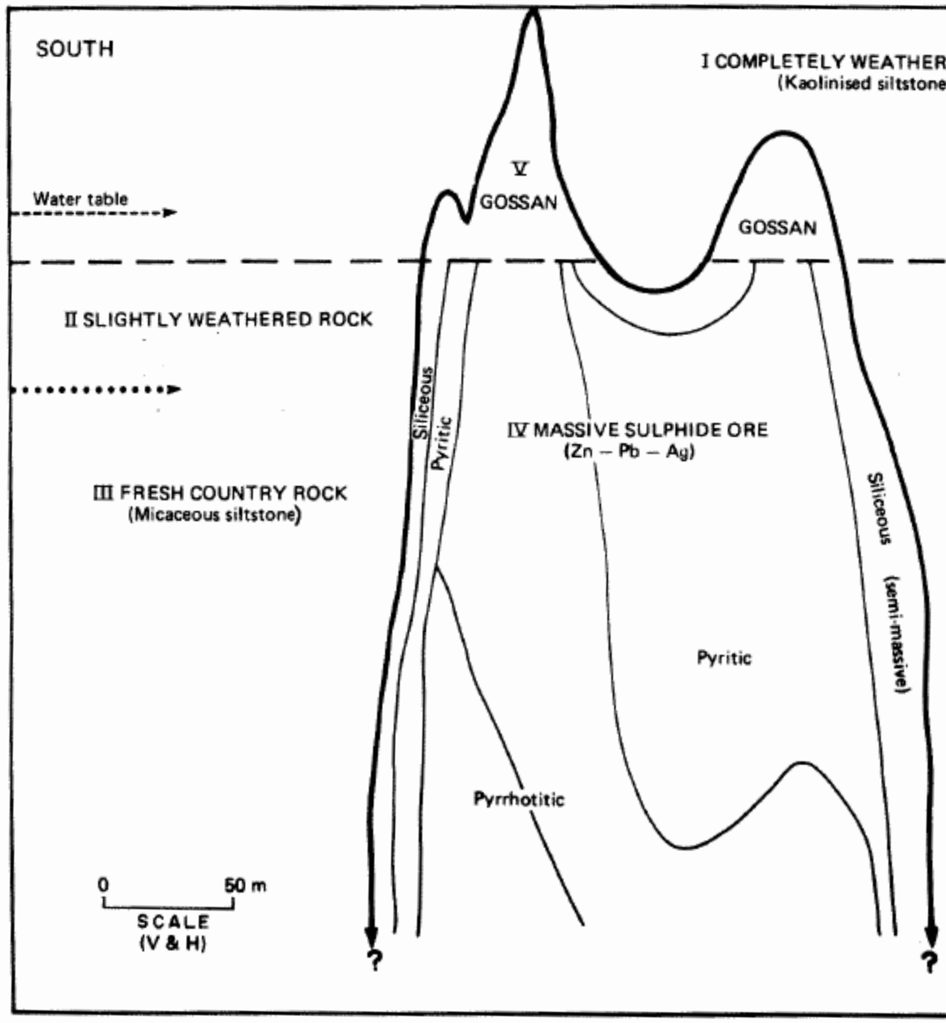
D.J.Woolman, Government Printer.





The Elura Compendium

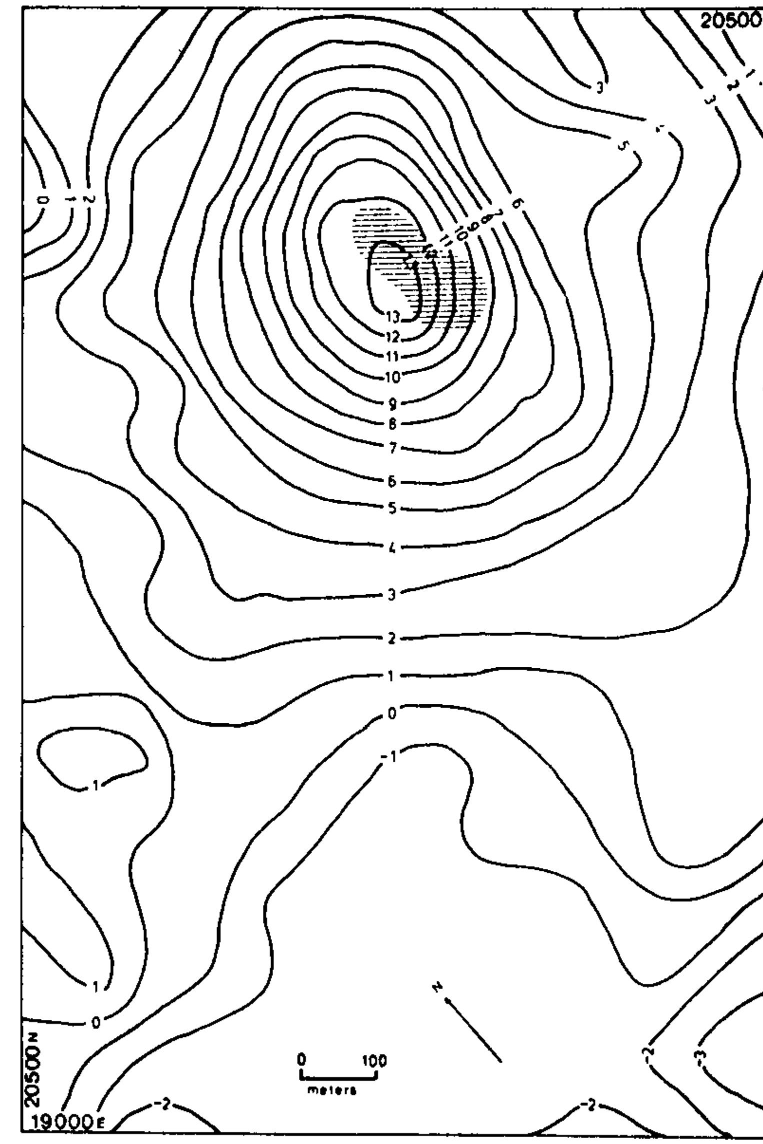
D. W. Emerson



PHYSICAL PROPERTY ZONES
ELURA ORE BODY, COBAR, N.S.W.
(Refer to table)

SCHEMATIC LONGITUDINAL SECTION

High resistivity surficial layer omitted
Boundaries (especially gossan) inferred & approximate



Estimated Average Bulk Physical Properties — Elura Orebody Zones	I Completely Weathered Country Rock	II Slightly Weathered Country Rock	III Fresh Country Rock	IV Sulphide Ore Si	Py	Po	V Gossan
Lithology	quartz kaolin sericite rock	quartz muscovite siltstone		semi massive to dissem siliceous	massive pyritic	massive pyrrhotitic	limonite
Weathering	intense	very slight	none	none	none	none	intense
Porosity, %, Total (Effective)	12 (7)	2 (0.3)	< 1		≪< 1		20 (11)
Permeability. cm/sec.	10^{-3} to 10^{-4} (fair to poor)	10^{-3} to 10^{-5} within 80 m of ore (∵ jointing), 10^{-7}			10^{-7} (impermeable)		10^{-1} to 10^{-2} (good)
Dry Bulk Density gm/cc.	2.3	2.7	2.75	3.7	4.5	4.4	3.0
Water Saturation, S_w%	50+(?)	100	100	0	0	0	≤50 (?)
Resistivity ohm m	10-20	500±	1500±	35	0.3	0.1	300±
Percent Frequency Effect (IP)	very small	minor	minor	220	25	15	small (?) at depth
Magnetic Susceptibility, cgs x 10^6	20	30	30	10	70	3000±	50
Koenigsberger Ratio, Q_n	0.1	0.1	0.1	0.1	0.1	5±	3
Velocity, V_p, m/sec	1200 – 4000	5000	5500		5600		4000 surface, 4300 @ depth

later workers. Electromagnetic measurements are briefly discussed. A full discussion of the integrated approach is contained in a further paper (Blackburn, 1980). *All discussions and results are those presented in 1974.*

Aeromagnetic Interpretation

Previous aeromagnetic surveys (e.g. Thomson, 1953 and Richardson & Keating, 1947) have produced very small (up to 40 nanoTesla [nT]) anomalies over the Cobar ore bodies.

During May, 1972, a low level (90 m) reconnaissance aeromagnetic survey was flown for the Electrolytic Zinc Company of A'asia Ltd. over their Cobar license. Results were accurate to 1 nT. Of fifteen selected anomalies only one, the Elura prospect was substantiated by later ground reconnaissance magnetics. The other anomalies were due to

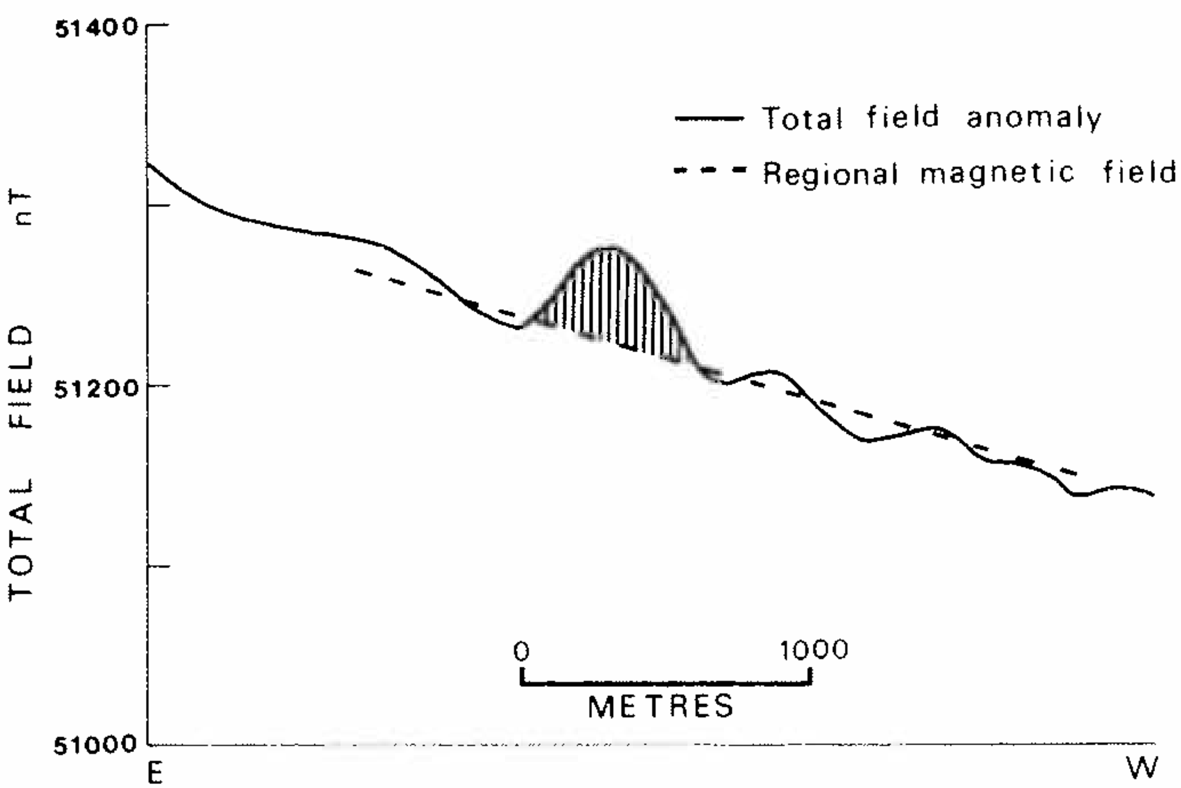


FIGURE 1

Total intensity air magnetic profile over the Elura prospect

bodies are small and thus easily masked by the effects of topographic irregularities, moderate variations in the thickness and composition of the overburden and regional anomaly trends due to relatively deep-seated masses.

Yungul (1956) illustrates the small magnitude of gravity anomalies obtained even on compact spherical ore masses (Figure 3). It is therefore imperative that the overall survey accuracy be maintained to an extremely high precision.

From December, 1973, until March, 1974, 374 stations were occupied with a Worden gravity meter. Readings were

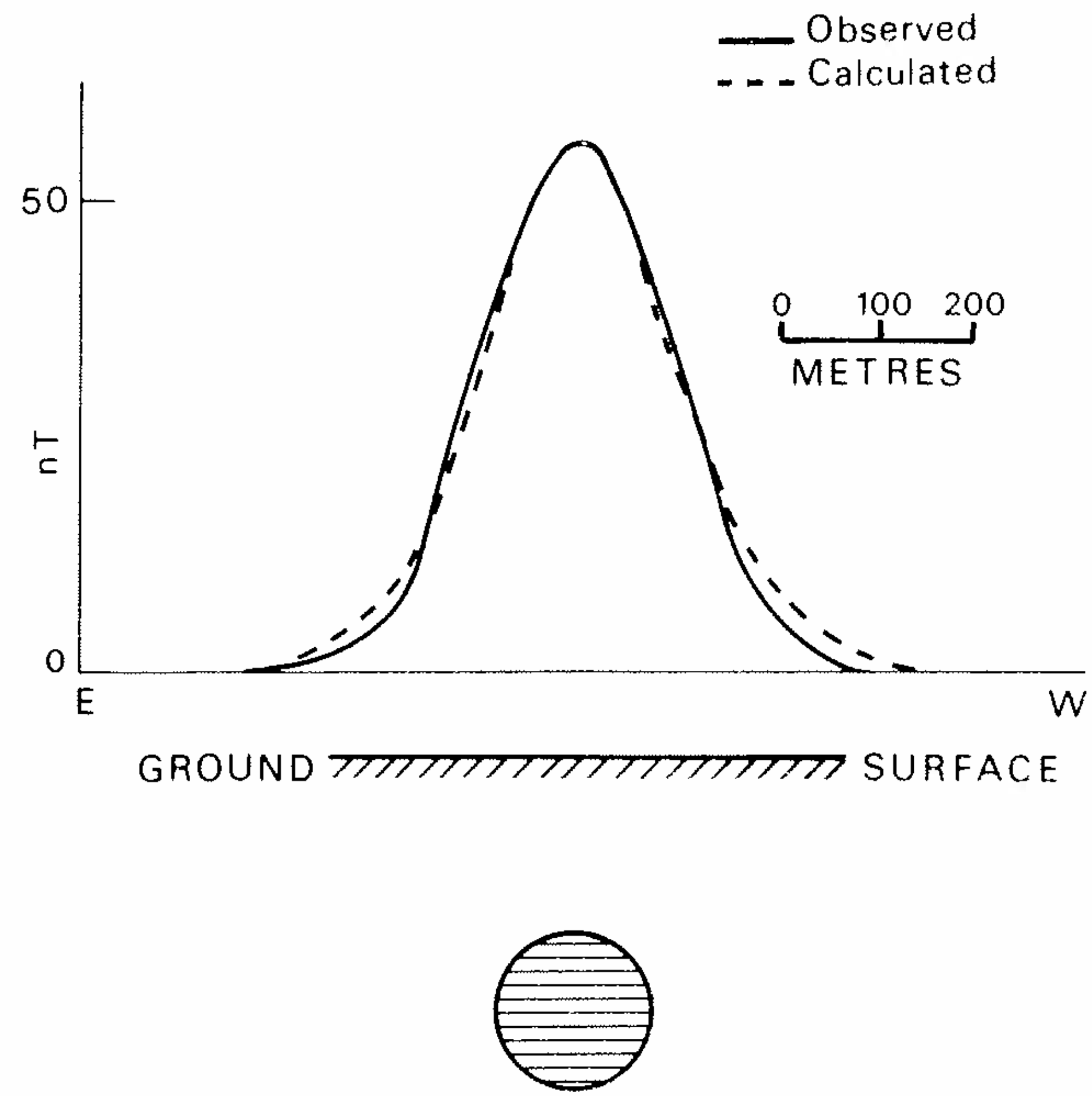


FIGURE 2

Comparison of theoretical and observed total field magnetic anomalies for a spherical source

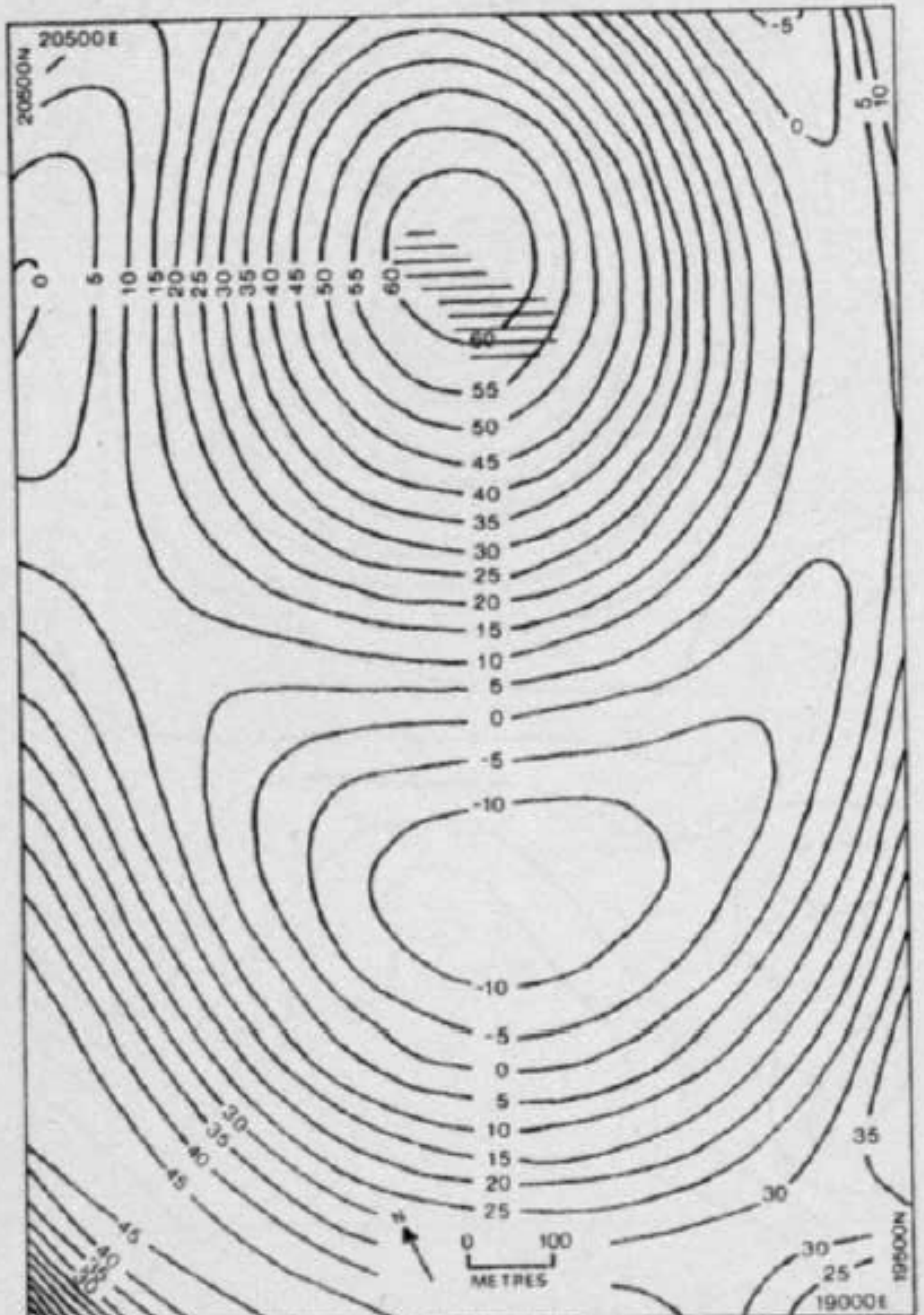
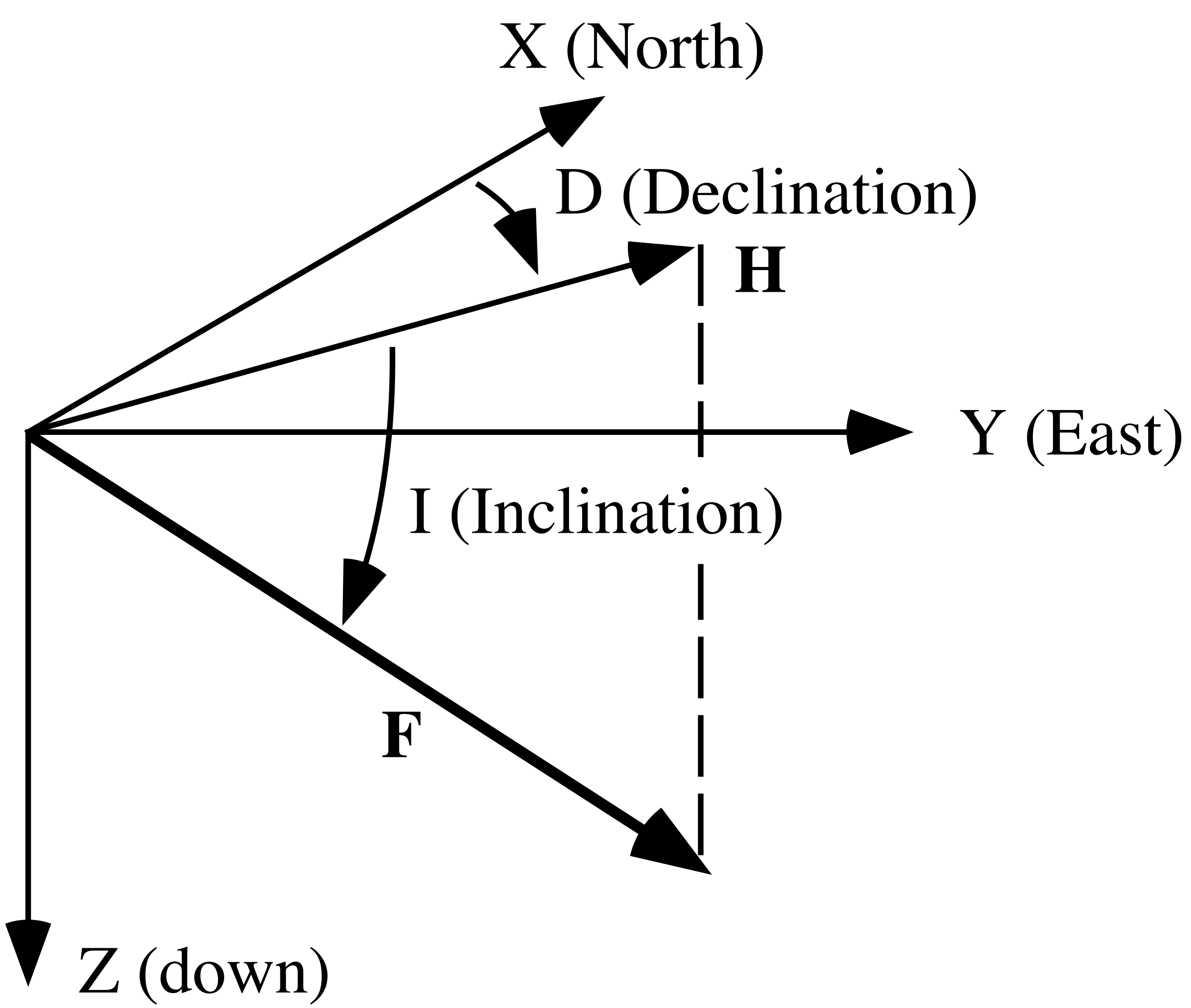


FIGURE 9

Smoothed trend surface ground magnetic anomaly. Contour interval 5 nT

The magnetic coordinate system:



Various types of magnetic measurements:

Can measure directions, D and I

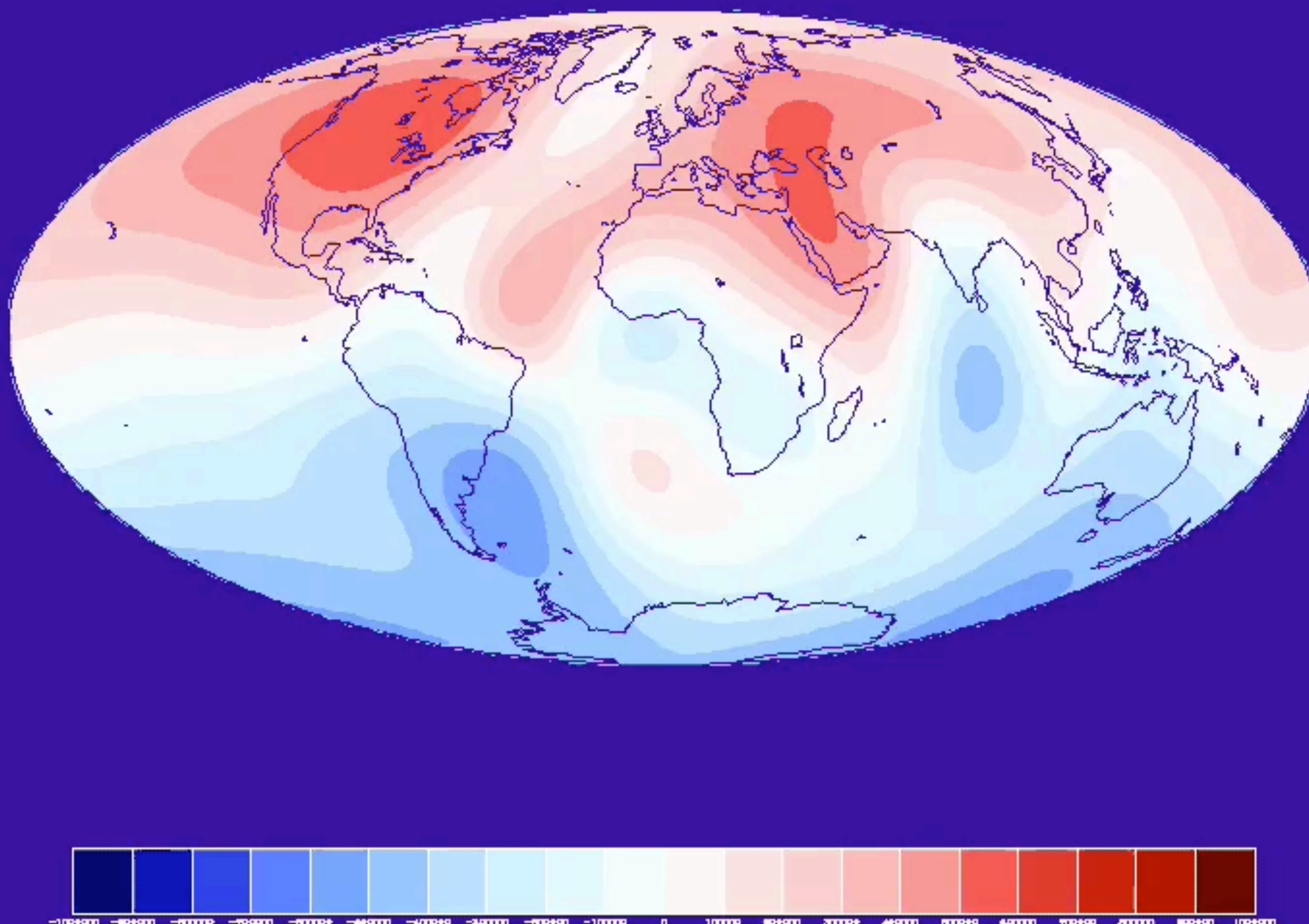
Can measure the total field, |**F**|

Can measure the components, (X, Y, Z)

Sensors are either total field or vector.

Can measure only the high frequency variations

1590 (gufm1)



Nuclear precession magnetometers:

Proton precession magnetometer (PPM)

Lamor precession frequency f is proportional to the magnitude of the magnetic field B

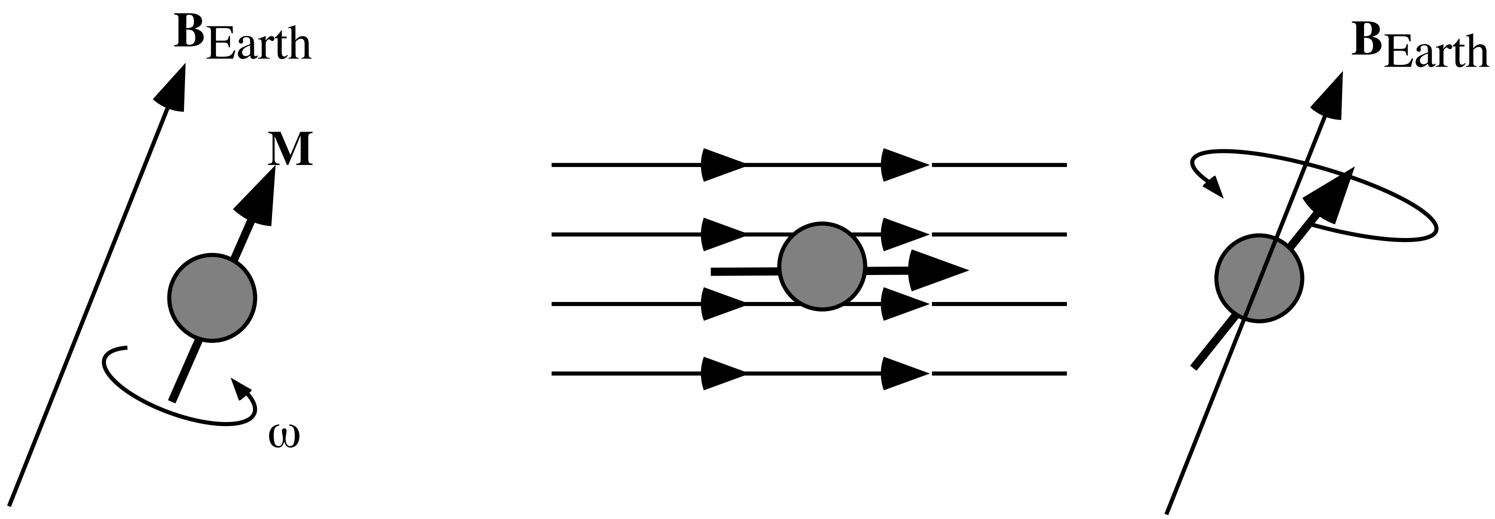
A proton has a magnetic moment as well as spin angular momentum

A strong polarizing magnetic field aligns the proton at a high angle to Earth's field

Upon removal of the polarizing field, the proton precesses about Earth's field

$$\omega = \gamma_p B$$

$$f = \frac{\gamma_p}{2\pi} B$$



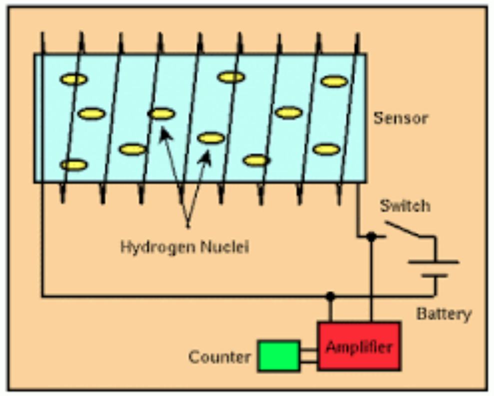
The gyromagnetic ratio of the proton is the ratio of magnetic moment to spin angular momentum:

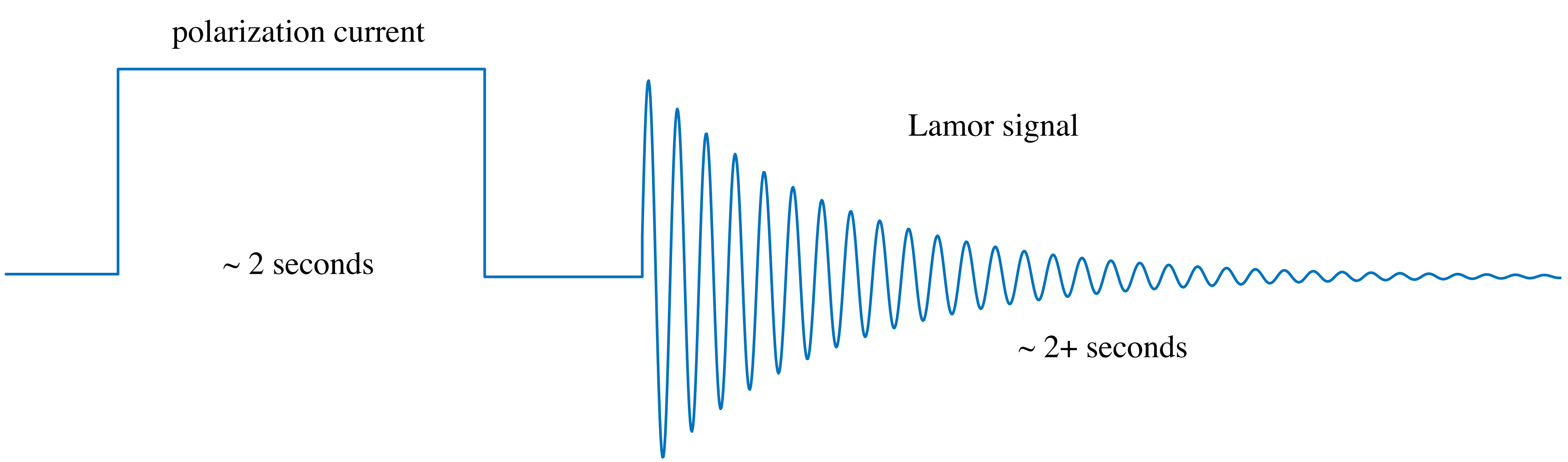
$$\gamma_p = 2.675 \times 10^8 \text{ radians T}^{-1} \text{ s}^{-1}$$

$$B_{\text{Earth}} = 2\pi f/\gamma_p \quad (23.4859 \text{ nT/Hz})$$

Nuclear precession magnetometers - PPM:

The PPM is simple and gives an intrinsically calibrated measurement of total field. However, it is power hungry, it takes about several seconds to integrate a signal, and has a resolution of around 1 nT.





Nuclear precession magnetometers:

We can estimate the gyromagnetic ratio by considering the charge on the spinning proton or electron as being distributed in a circular circuit:

The current in this circuit is then charge times velocity divided by circumference:

$$I = \frac{qv}{2\pi r}$$

The magnetic dipole of a single loop is current times area:

$$D_M = IA = \frac{qv}{2\pi r}\pi r^2$$

Cancelling *pi-r* and multiplying by *m/m* where *m* is the mass of the proton or electron:

$$D_M = \frac{q}{2m} mvr$$

The second term *mvr* is just angular momentum, so the ratio of dipole moment to angular momentum is

$$\frac{D_M}{mvr} = \gamma = \frac{q}{2m}$$

This gets you close - the estimate of off by the *g-factor,* 5.58 for the proton and 2.002 for the electron. These are quantum mechanical effects that are sorta predictable.

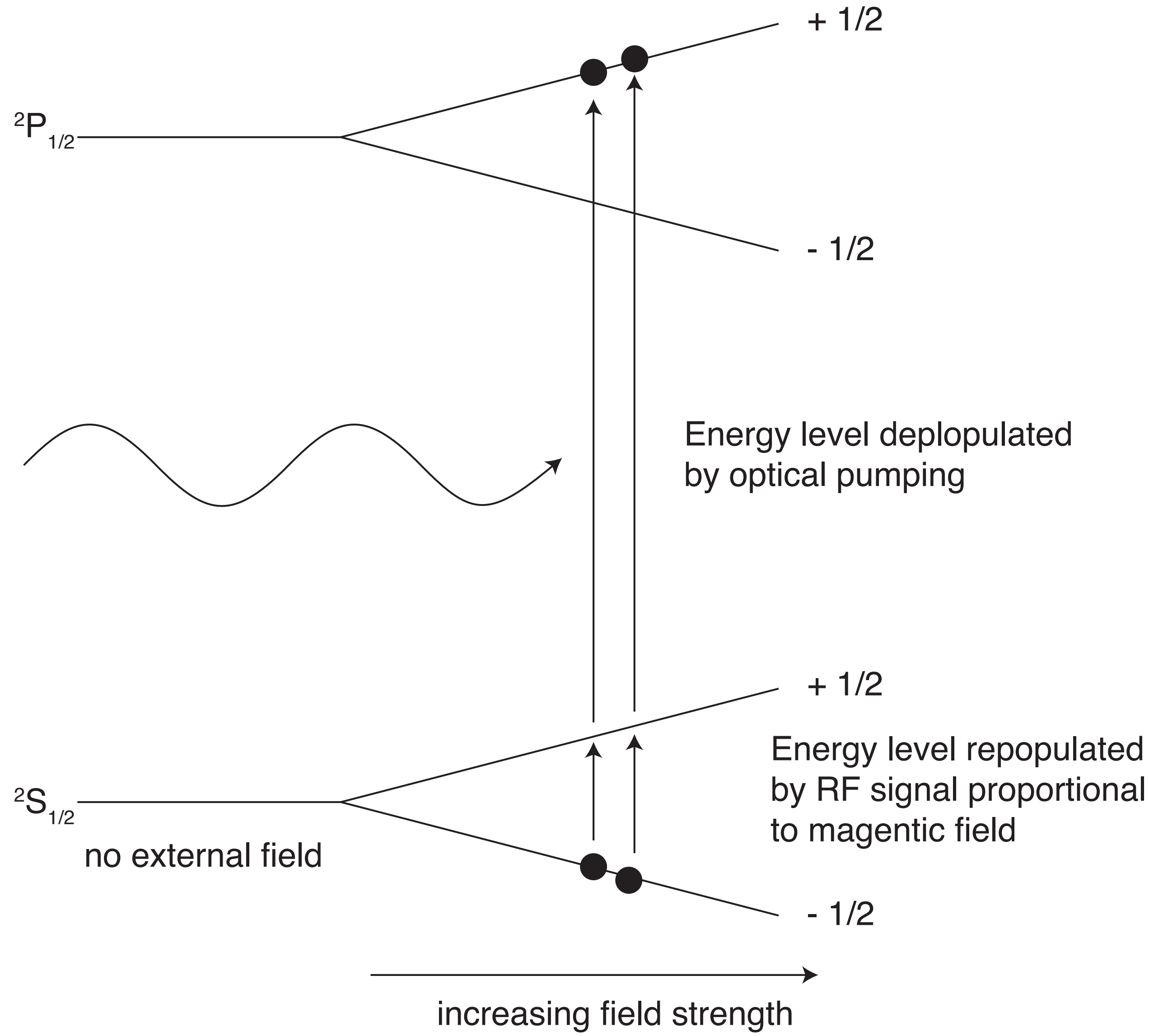
Nuclear precession magnetometers:

Alkali vapor magnetometers use Zeeman splitting.

$$\gamma_e = 1.761 \times 10^{11} \text{ radians } \mathrm{T}^{-1}\mathrm{s}^{-1}$$

Cesium

Rubidium

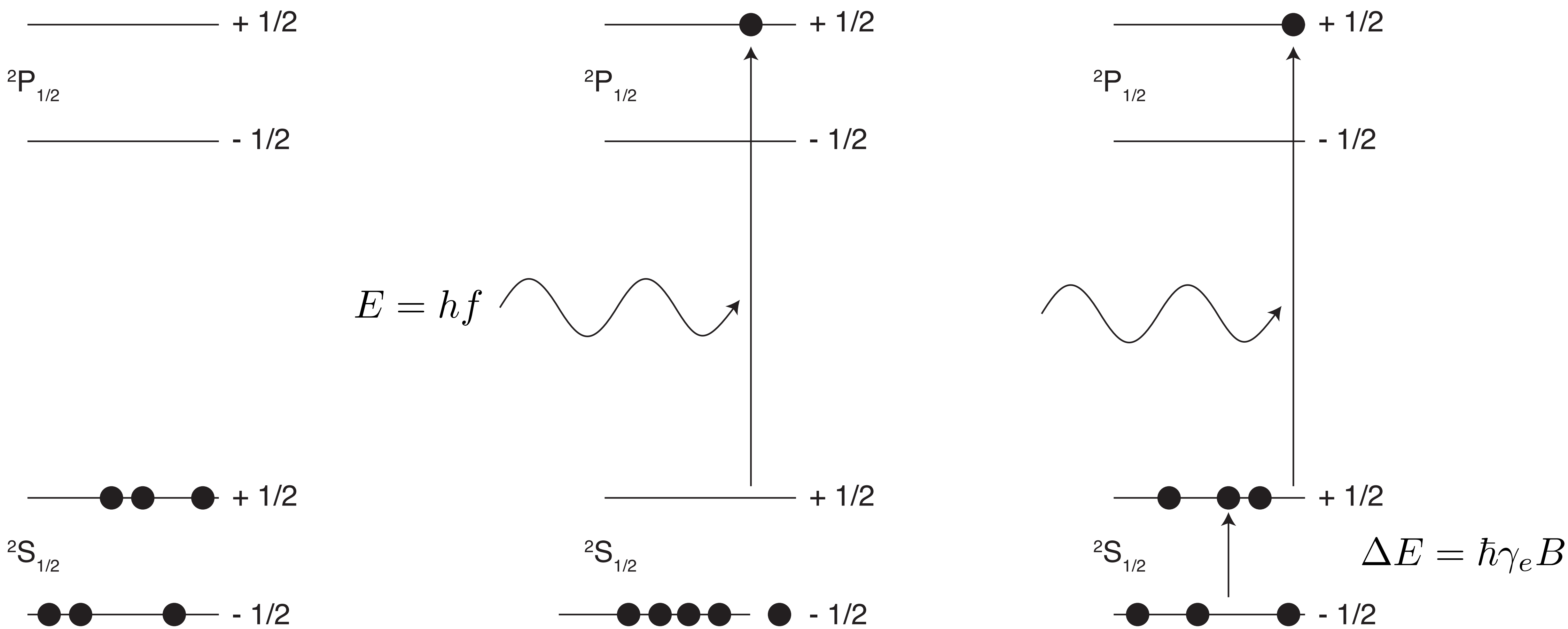


$$E = hf$$

$$\Delta E = \hbar \gamma_e B$$

$$f = \gamma / 2\pi B$$

Nuclear precession magnetometers:



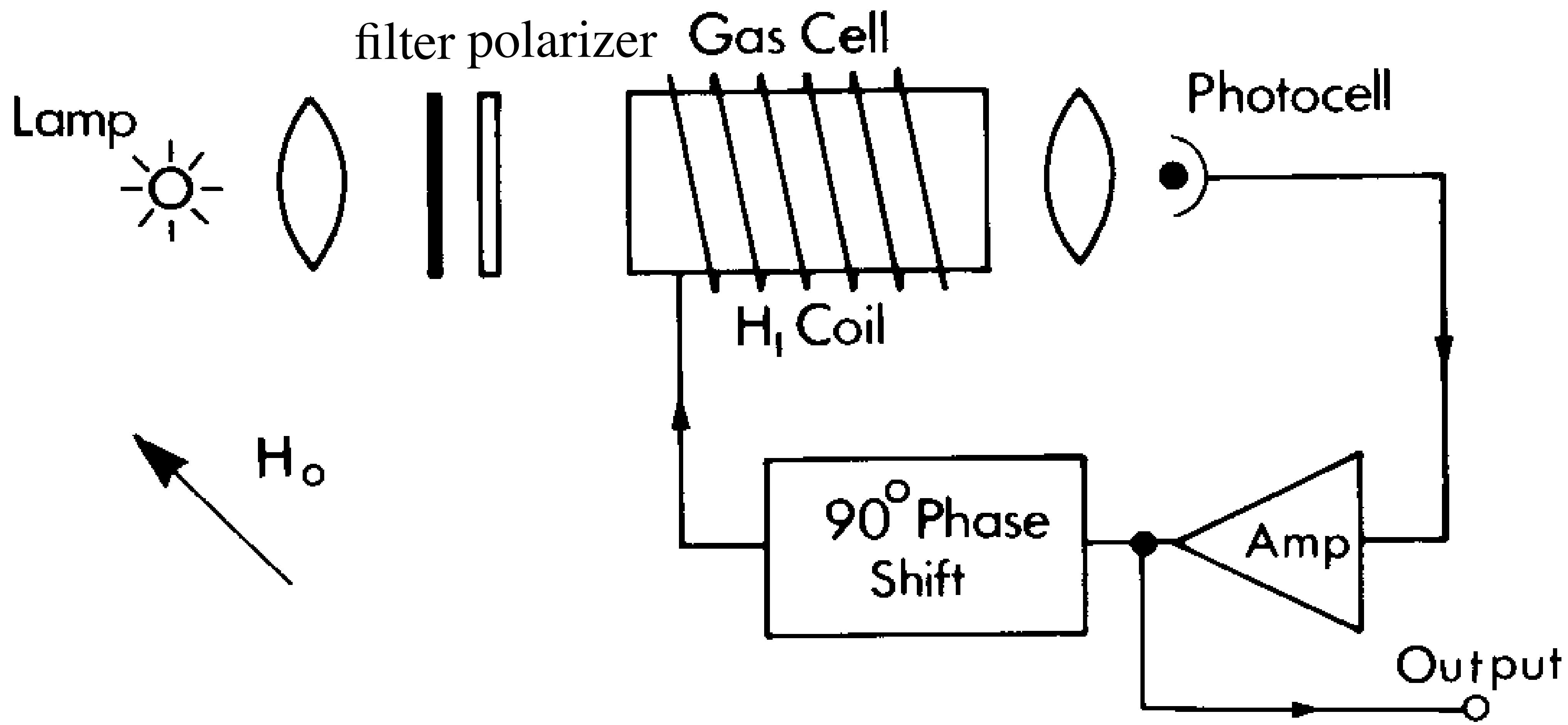
Electrons divided equally in the ground states.

+1/2 energy level deplopulated by optical pumping. Polarized light only couples to +1/2. Cell goes transparent.

+1/2 level repopulated by RF signal proportional to magentic field. Cell starts absorbing light and goes dark.

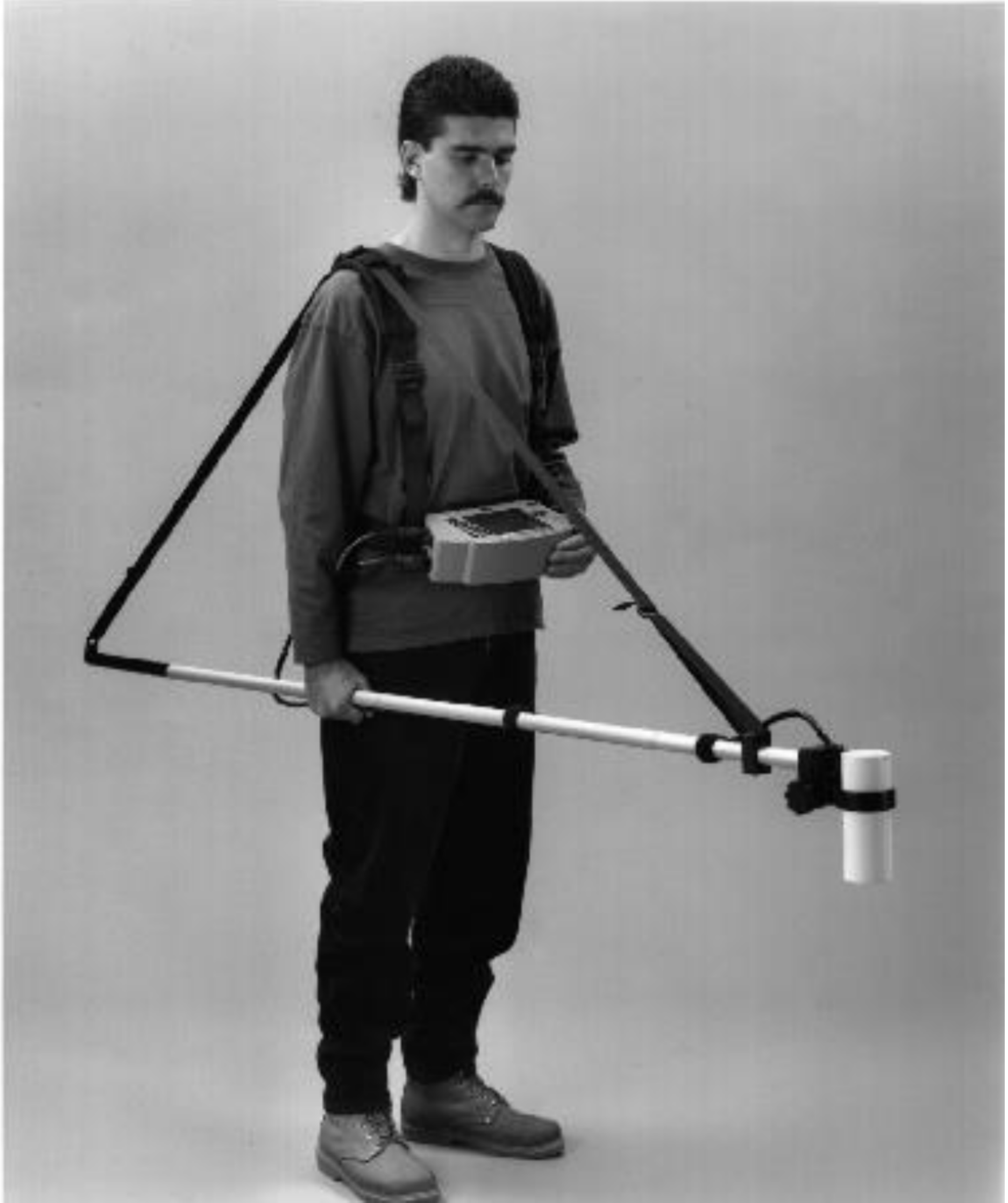
Nuclear precession magnetometers:

Rather than sweep through the radio frequencies, cesium magnetometers are run as a feed-back circuit.

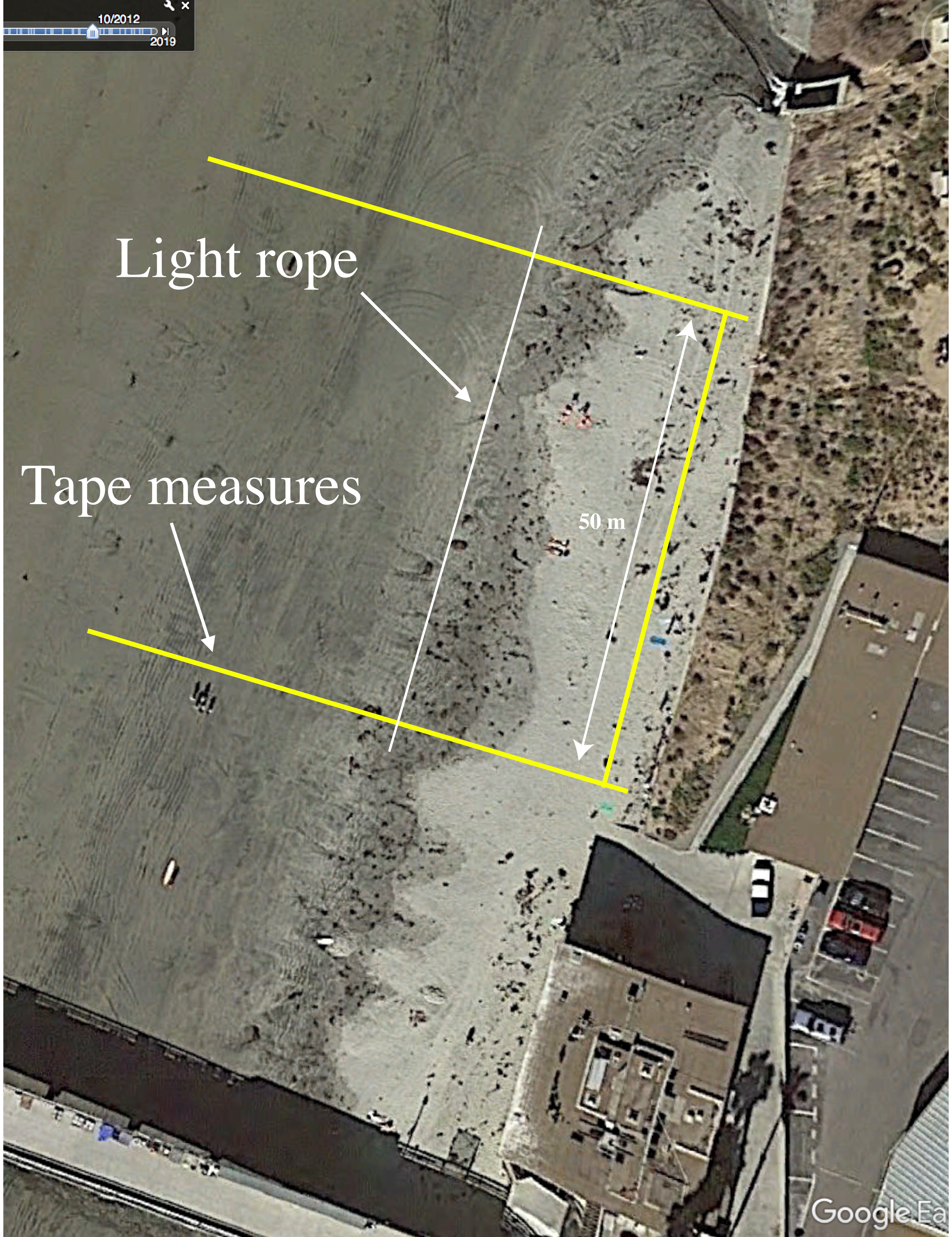


GEOMETRICS
POWER
AUDIO
SCALE
DARK
LIGHT
END LINE
MARK
PAUSE
ESC
MENU
DEL
CHART
MAP
ENTER
DATA MAPPER

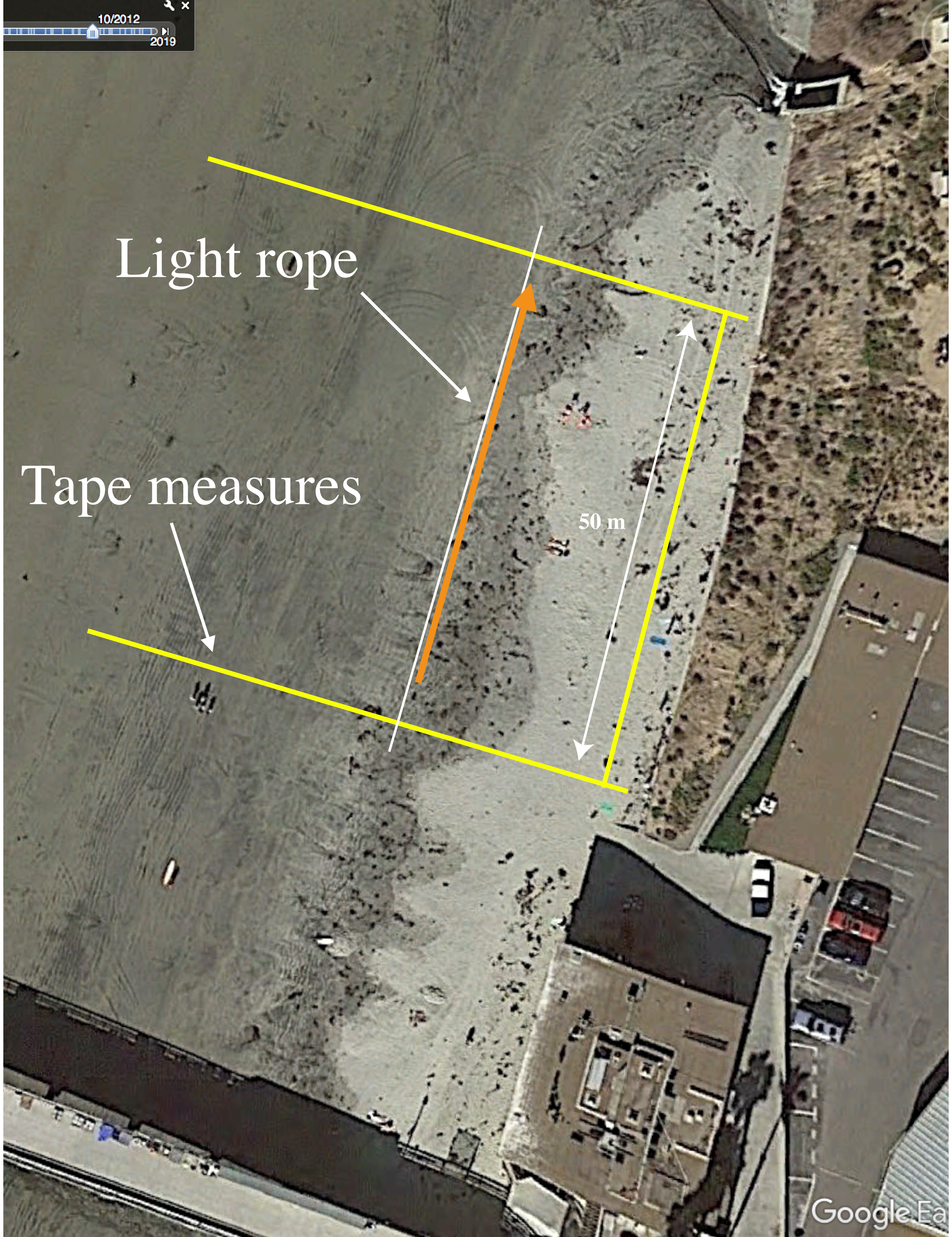

GEOMETRICS
AUDIO
SCALE
DARK
LIGHT
END LINE
MARK
HI
BAT
LO
LO
MEM
HI
1
2
3
4
5
6
7
8
9
0
MENU
DEL
CHART
MAP
PAUSE
POWER
G 858 MAG MAPPER

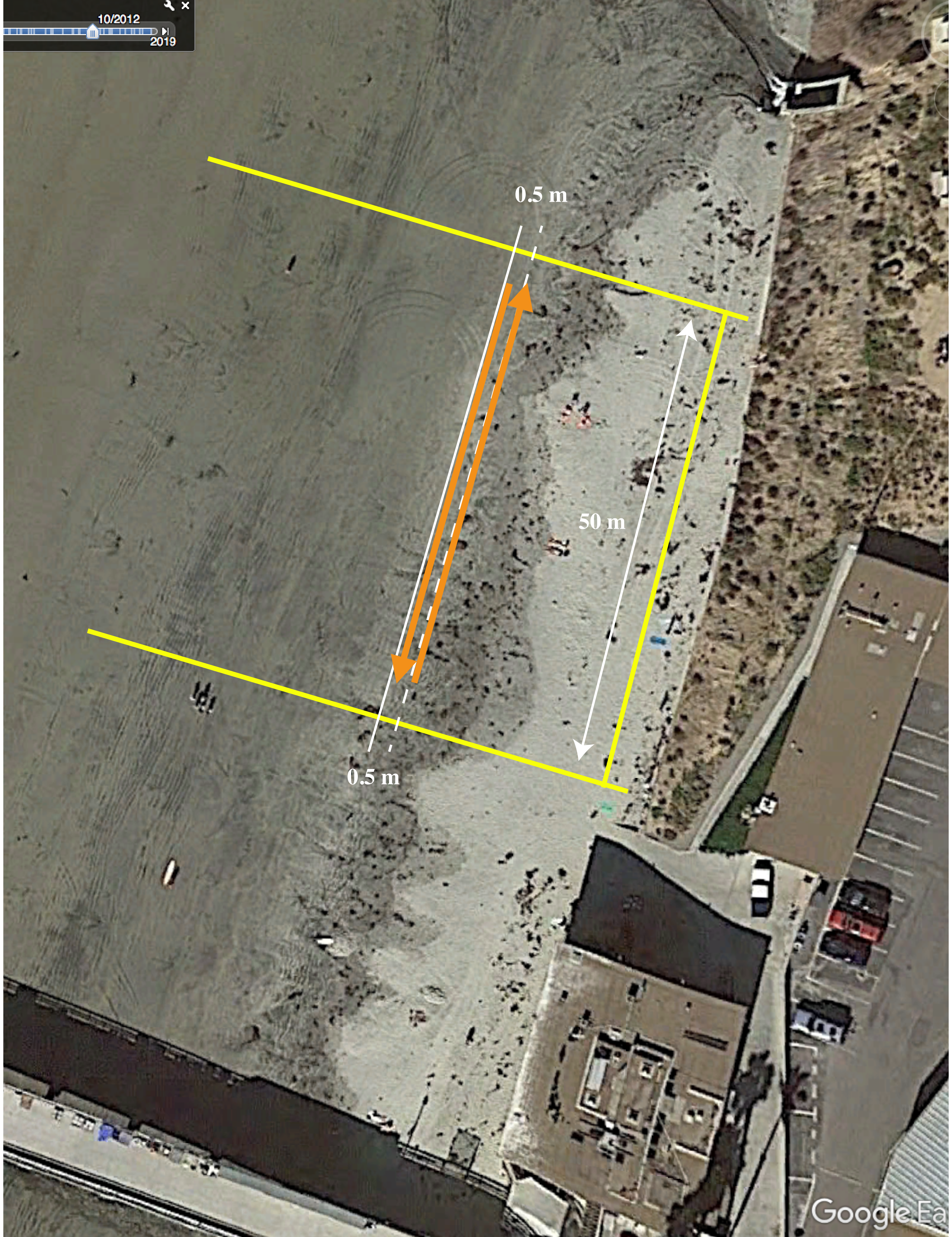


Biological Grade
Downwind Way
Naga Way

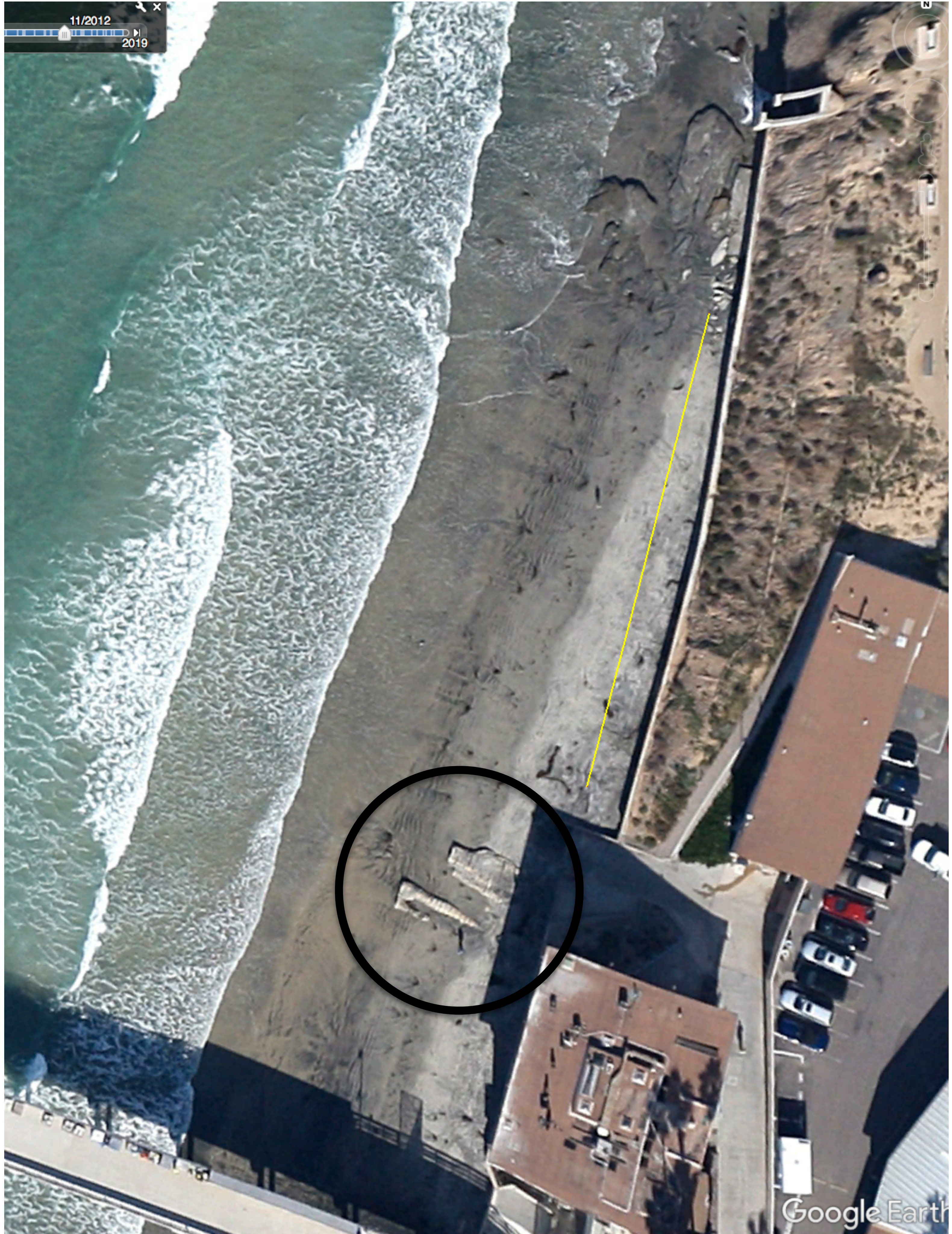


10/2012
2019
Light rope
Tape measures
50 m
Google Ea


10/2012
2019
Light rope
Tape measures
50 m
Google Ea



10/2012
2019
0.5 m
50 m
0.5 m
Google Ea


11/2012
2019
Google Earth


SCRIPPS COASTAL RESERVE


1 m cord
fiberglass tape
light rope

Data are stored as LIFO

```
3          0.00          0.00 01:34:14.50 05/02/19          4          51          3   5   stop data
0     46234.386       0.000 01:34:14.30 05/02/19    0
0     46233.679       0.000 01:34:14.00 05/02/19    0
0     46232.257       0.000 01:34:13.70 05/02/19    0
0     46230.709       0.000 01:34:13.40 05/02/19    0
3          0.00          0.00 01:34:13.20 05/02/19        116          51          2   4   mark
0     46230.419       0.000 01:34:13.10 05/02/19    0
0     46230.290       0.000 01:34:12.80 05/02/19    0
0     46232.297       0.000 01:34:12.50 05/02/19    0
0     46233.068       0.000 01:34:12.20 05/02/19    0
0     46233.171       0.000 01:34:11.90 05/02/19    0
0     46229.037       0.000 01:34:11.60 05/02/19    0
                                                   .
                                                   .      these are the data we want
                                                   .
                                                   .
0     46192.241       0.000 01:33:40.40 05/02/19    0
0     46191.561       0.000 01:33:40.10 05/02/19    0
0     46191.038       0.000 01:33:39.80 05/02/19    0
0     46190.044       0.000 01:33:39.50 05/02/19    0
0     46188.510       0.000 01:33:39.20 05/02/19    0
0     46186.797       0.000 01:33:38.90 05/02/19    0
0     46184.987       0.000 01:33:38.60 05/02/19    0
6          0.00          0.00 01:33:38.40 05/02/19          9          51          1   4   mark
0     46183.109       0.000 01:33:38.30 05/02/19    0
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0     46180.122       0.000 01:33:37.70 05/02/19    0
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0     46177.884       0.000 01:33:37.10 05/02/19    0
0     46176.780       0.000 01:33:36.80 05/02/19    0
0     46175.917       0.000 01:33:36.50 05/02/19    0
0     46175.090       0.000 01:33:36.20 05/02/19    0
0     46174.277       0.000 01:33:35.90 05/02/19    0
6          0.00          0.00 01:33:35.40 05/02/19          0          51          0  36   start data
3          0.00          0.00 01:33:24.50 05/02/19          4          50          3   5   stop  data
```

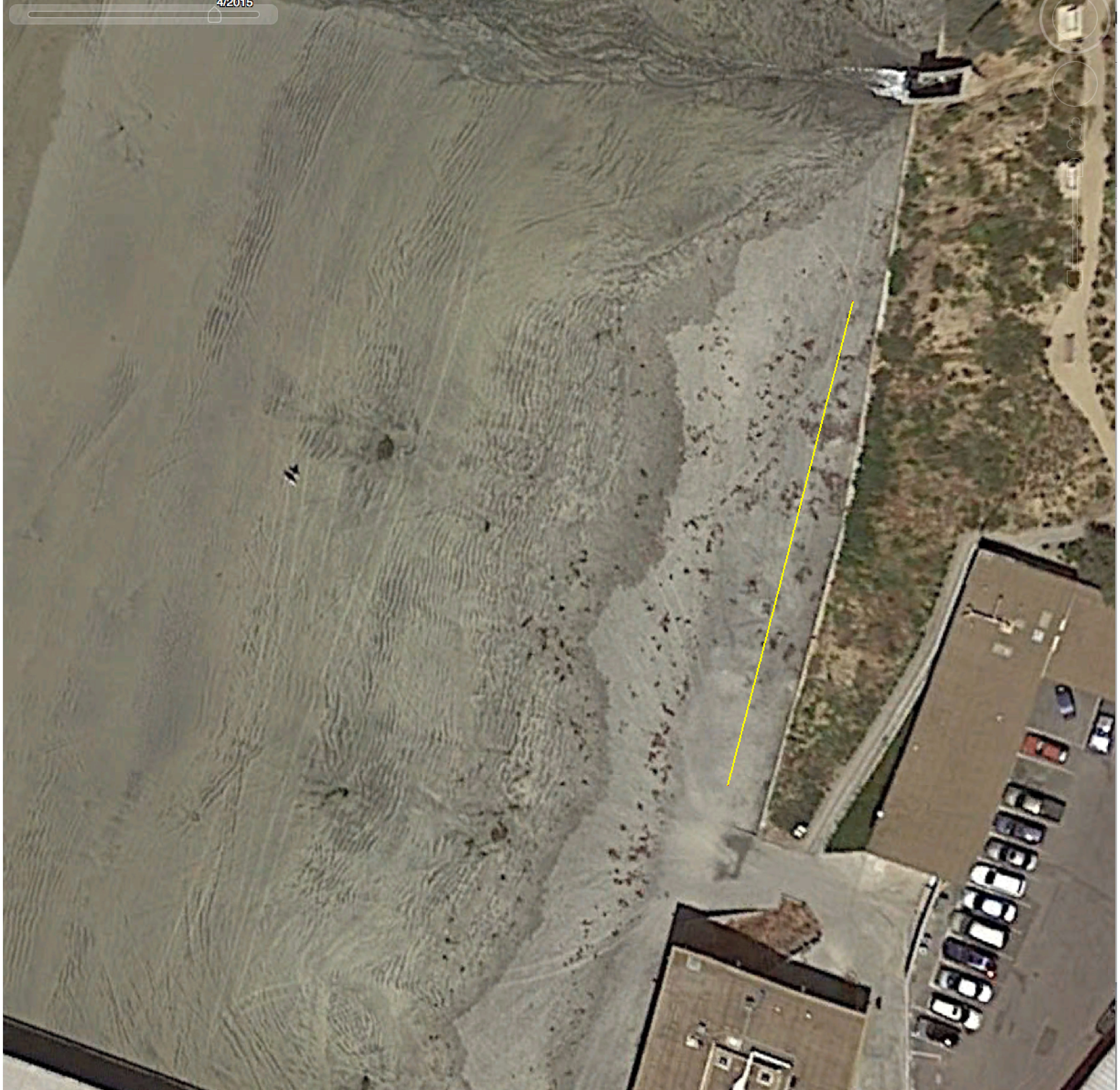
number of data collected

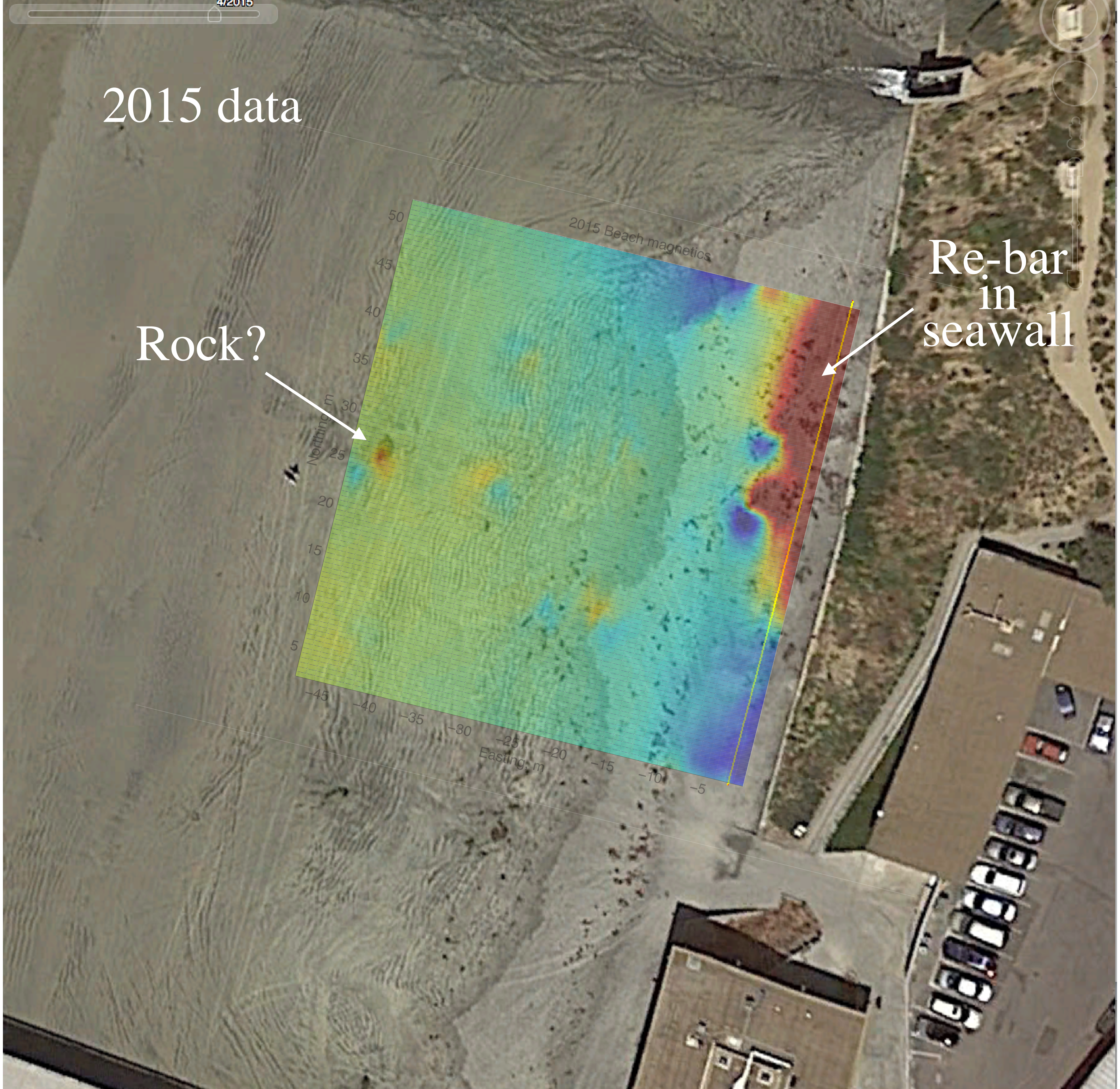
measurement, nT

time

line number

Data


4/2015


2015 data
Rock?
Re-bar
in
seawall
2015 Beach magnetics
Northing, m
Easting, m
50
45
40
35
30
25
20
15
10
5
−45
−40
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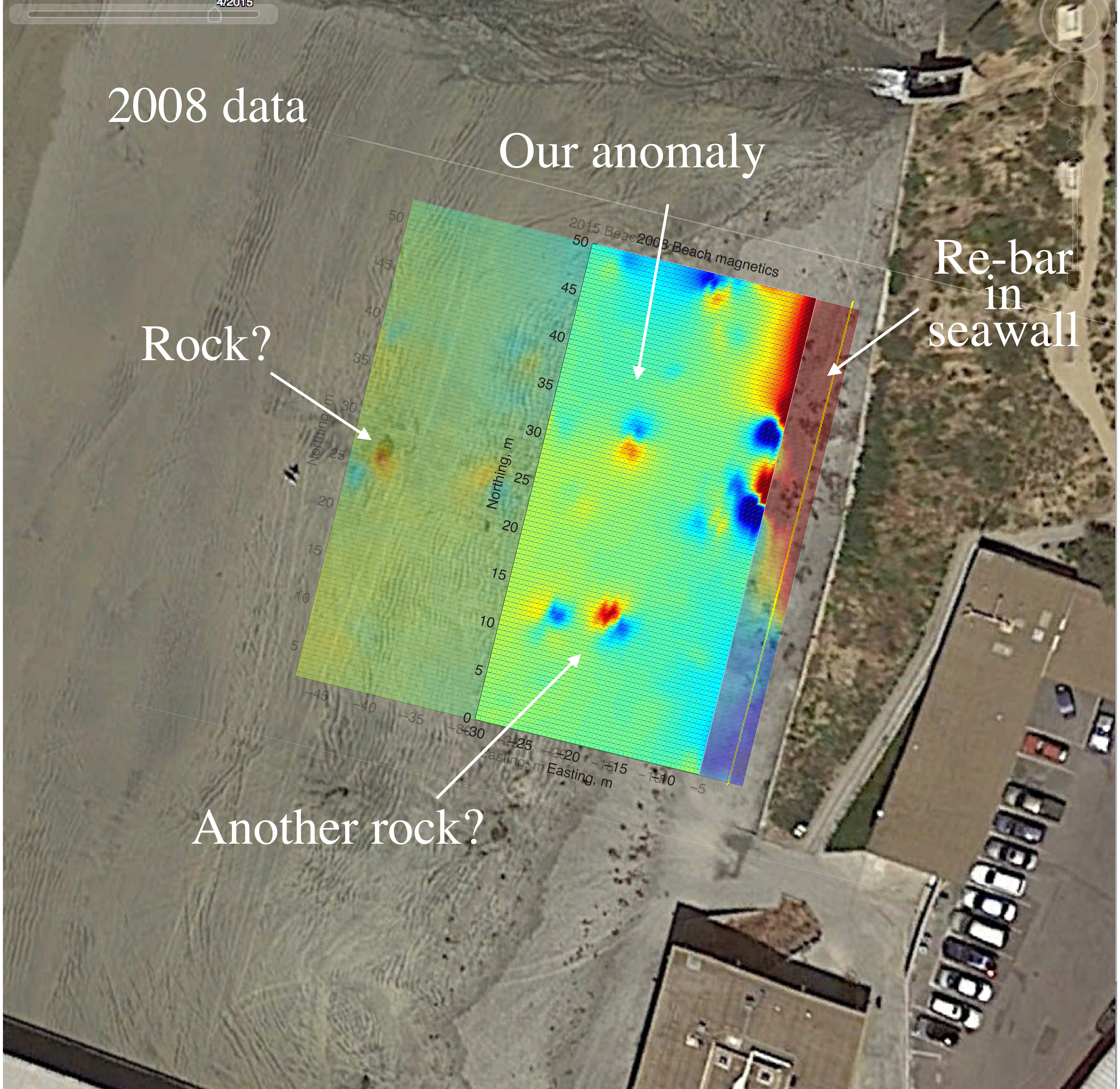
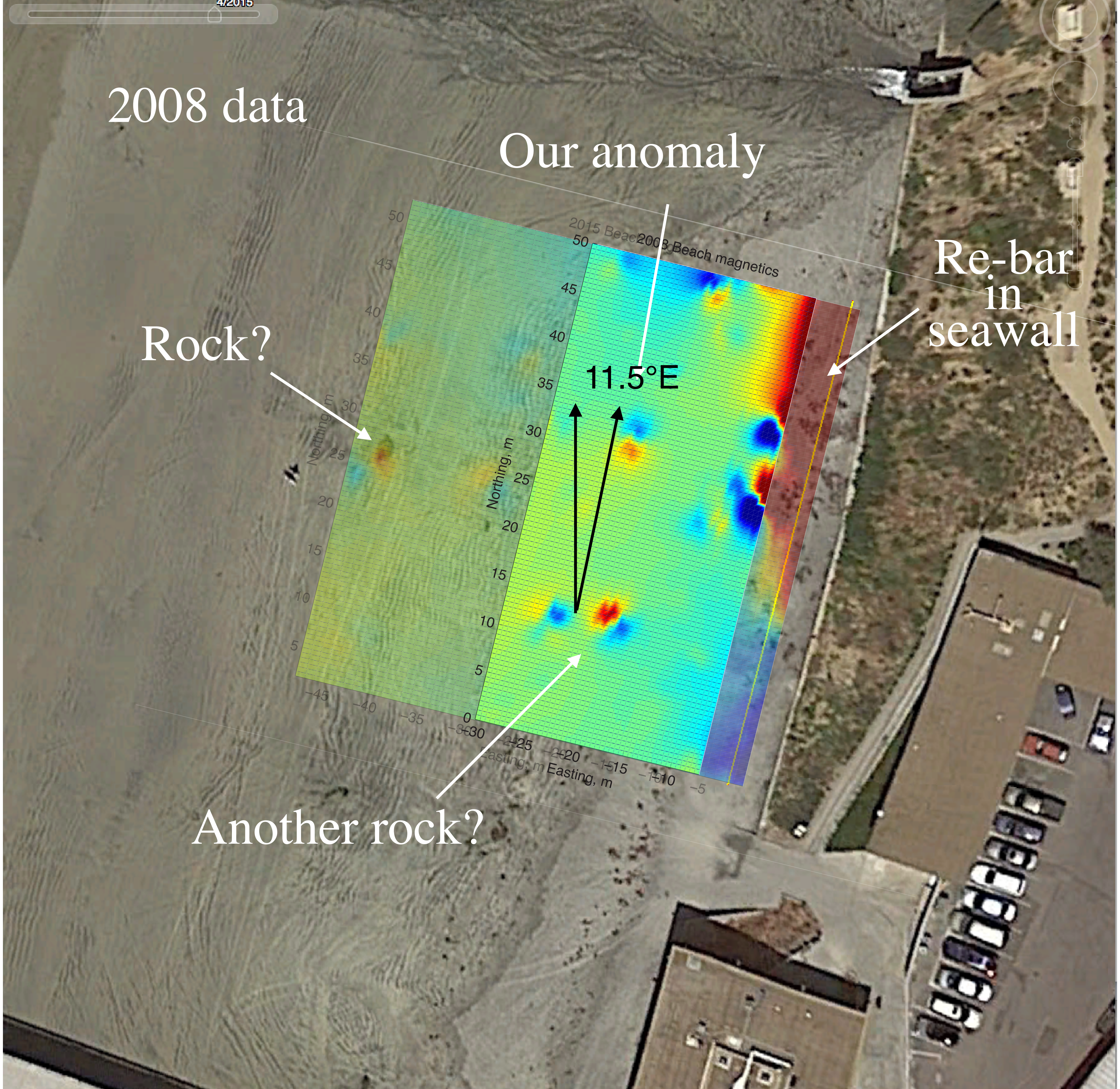
−20
−15
−10
−5


2008 data
Our anomaly
Re-bar in seawall
Rock?
Another rock?
2008 Beach magnetics
Northing, m
Easting, m



2008 data
Our anomaly
Re-bar in seawall
Rock?
11.5°E
2008 Beach magnetics
Northing, m
Easting, m
Another rock?

Tracing a Mutiny by Slaves Off South Africa in 1766

By SHARON LaFRANIERE
Published: August 24, 2005

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Correction Appended

STRUIS BAY, South Africa, Aug. 20 - After years of painstaking research and sophisticated surveys, Jaco Boshoff may be on the verge of a nearly unheard-of discovery: the wreck of a Dutch slave ship that broke apart 239 years ago on this forbidding, windswept coast after a violent revolt by the slaves.

Enlarge This Image

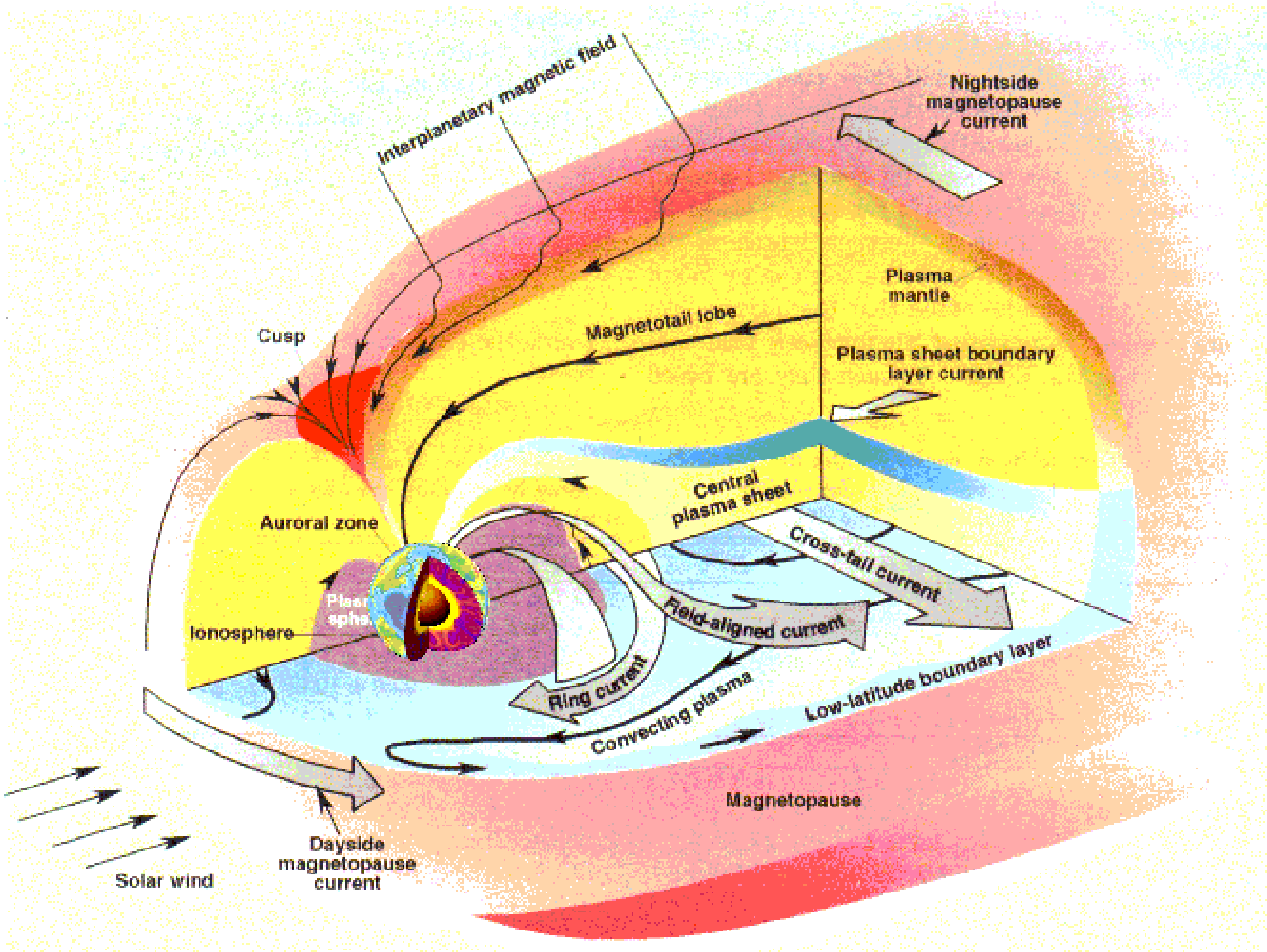

Guy Tillim for The New York Times

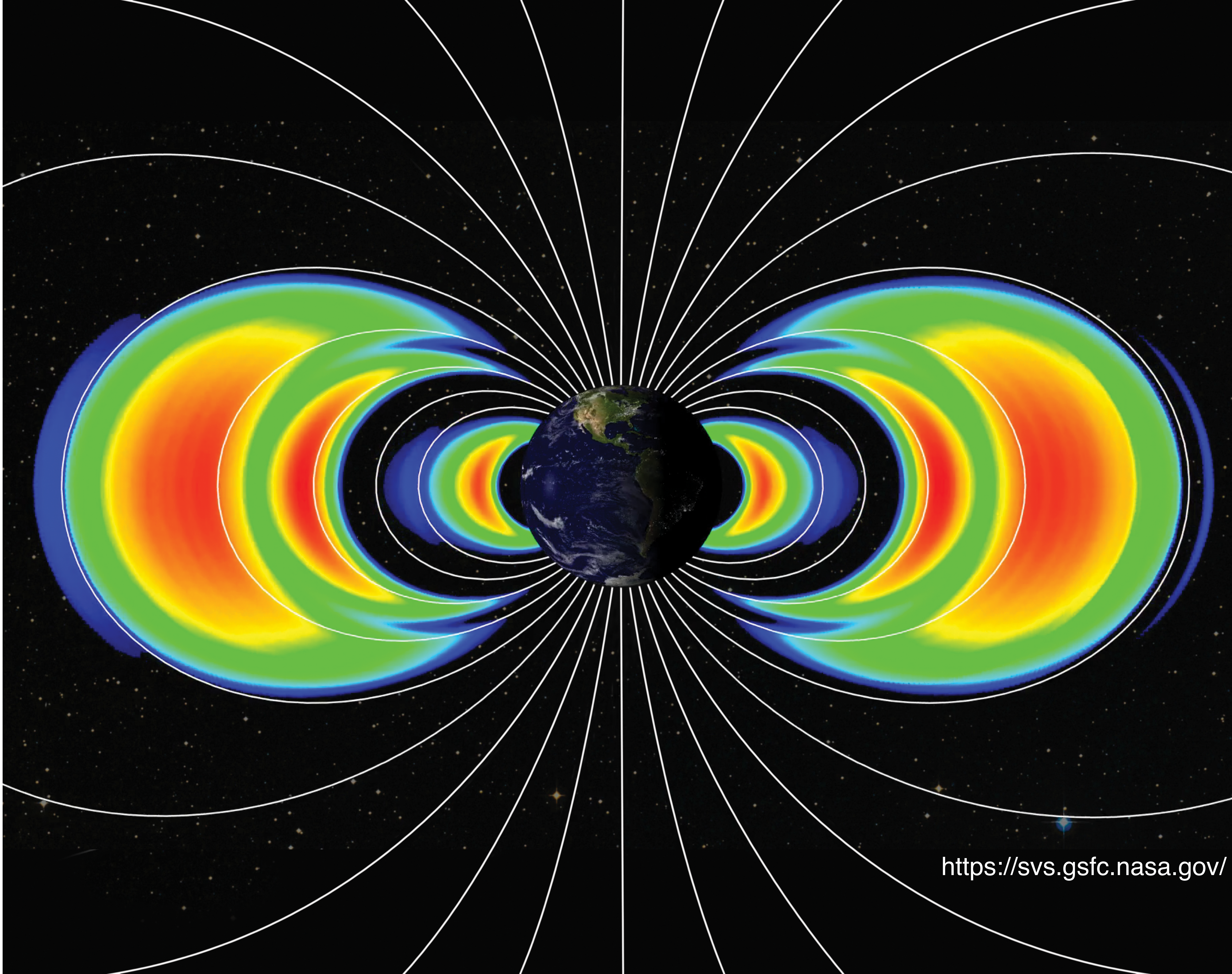
On the other hand, he may have discovered a wire fence covered with beach sand.

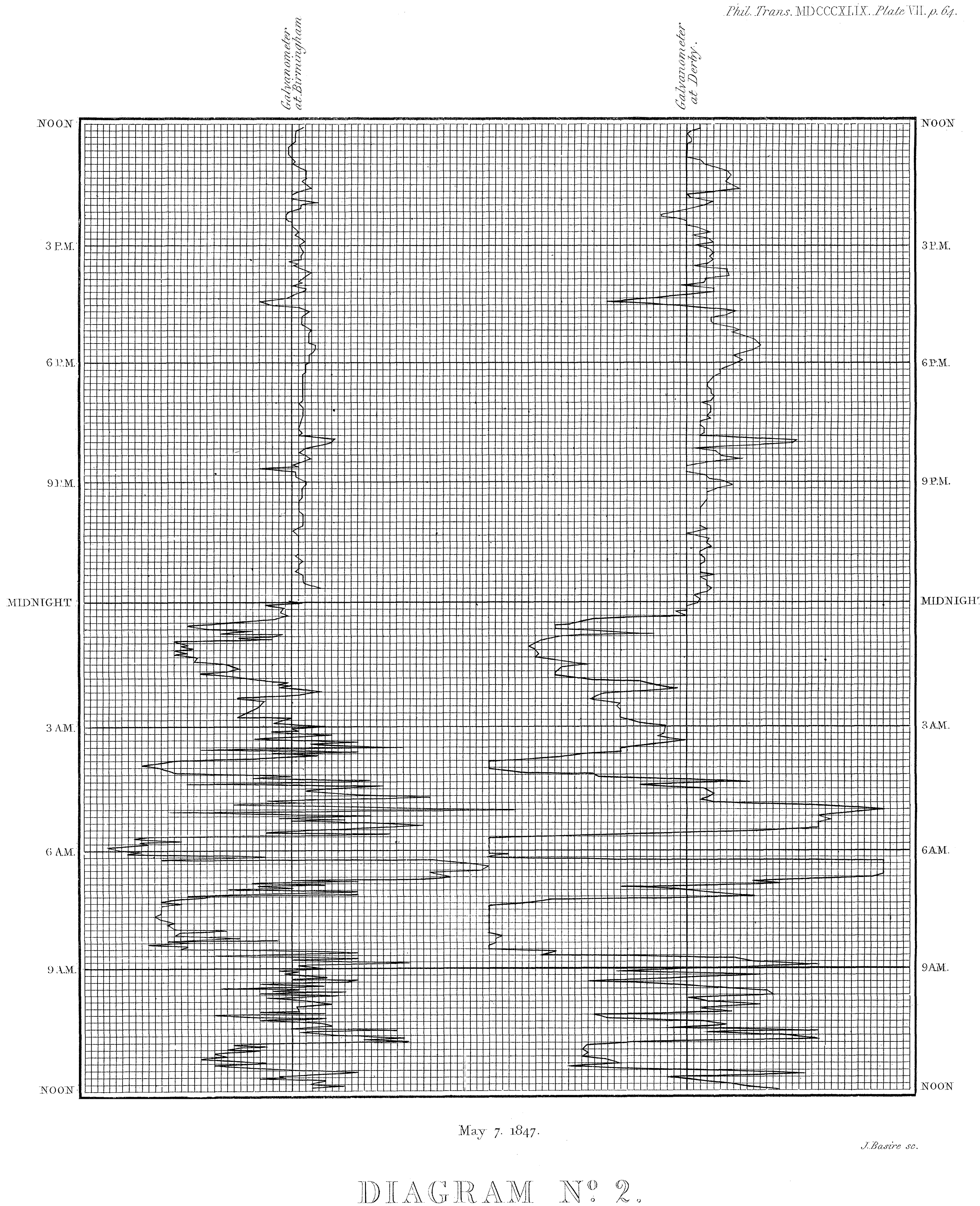
Mr. Boshoff, a 39-year-old marine archaeologist with the government-run Iziko Museums, will not find out until he starts digging on this deserted beach on Africa's southernmost point, probably later this year.

After three years of surveys

A spatial view of Earth's magnetic field:




https://svs.gsfc.nasa.gov/



Barlow, 1849, currents in UK telegraph cables.

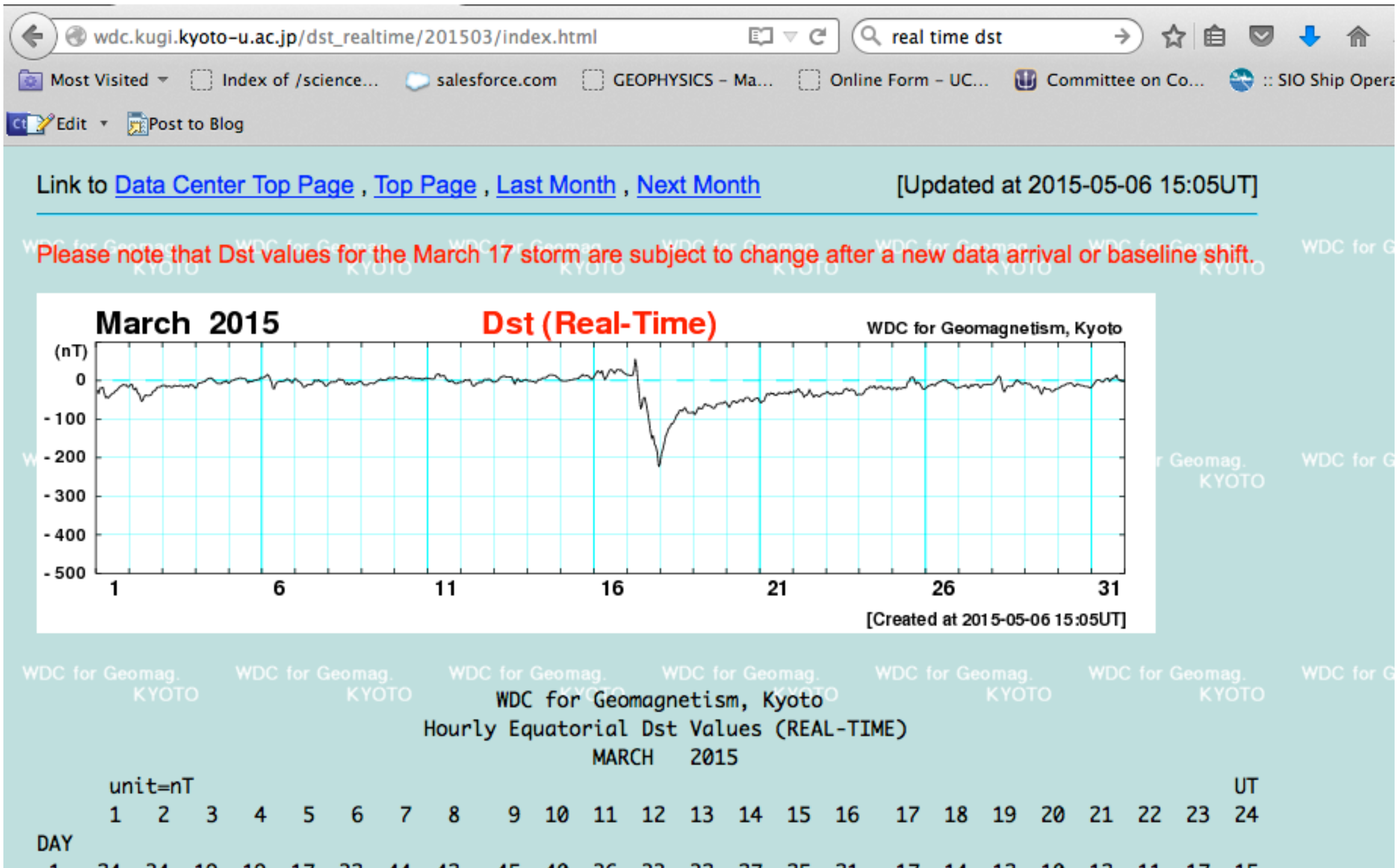
1838: Magnetic storm seen on telegraph cables.

1859: Carrington event, largest solar storm recorded.

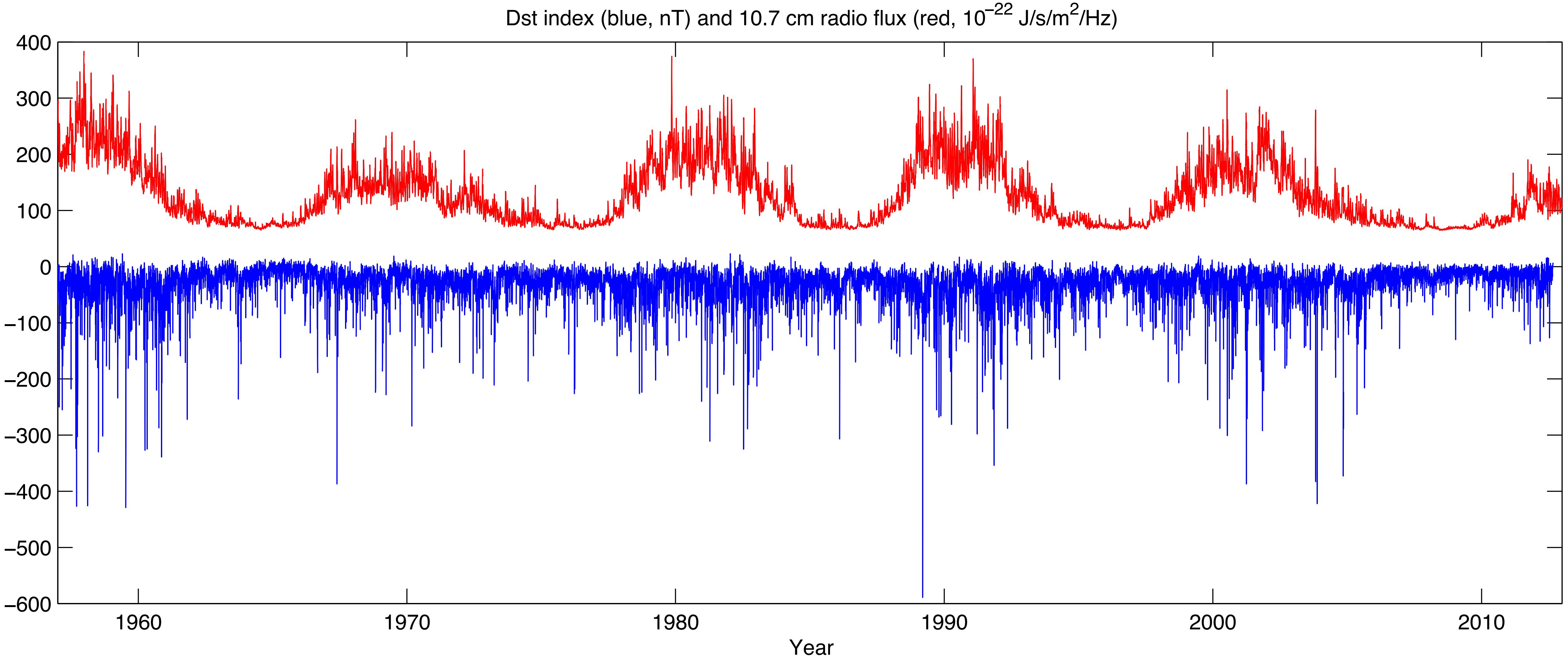
1989: Geomagnetic storm takes out Quebec power.

2012: Carrington-sized solar flare narrowly misses Earth.

Particles from the sun and magnetic storms inject particles into the ring current. The size of the ring current generated by solar activity is measured using the Dst index ("disturbed storm time"). Because the effect of the ring current is to *reduce* Earth's main field, storms go negative.



Magnetic storms are tied to the 11-year solar cycle, but not too strongly.



This Week's Solar Flare Illuminates the Grid's Vulnerability

By PETER BEHR of ClimateWire
Published: June 9, 2011

PRINT

A massive **burst of solar wind** that erupted from the sun Tuesday is expected to deliver only a "glancing blow" to the Earth's vulnerable magnetic field, NASA officials said yesterday. But it will preview what some experts call a potentially existential threat to the power grids of the United States and other nations, and the populations that depend on them.

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- The Tale of a Survivor in the Power Line Wars
- Multinational Panel Calls for Tougher 'Stress Tests' of Nuclear Plant Safety Systems
- After Explosive Growth, Global Carbon Markets Stall and Begin to Shrink
- How a Chinese Landfill Reduces Emissions While Attracting Tourists and Cash

Antti Pulkkinen, who leads NASA's "Solar Shield" satellite-based detection system at the Goddard Space Flight Center, said the cloud of ionized particles from Tuesday's violent "coronal mass ejection" will largely miss Earth, giving some North American residents a glimpse of the aurora borealis, or northern lights, this weekend. "It will not be a major event [for] the power grid," he said.

However, NASA spacecraft detected a much larger eruption last weekend on the backside of the sun headed away from Earth, generating a much faster-moving cloud.

"If this event was on a collision course with the U.S., we would have had a major space weather event," Pulkkinen said. "In this regard, we got lucky."

The next peak cycle of sunspot activity is predicted for 2012-2014, bringing with it a greater risk of large geomagnetic storms that can generate powerful rogue currents in transmission lines, potentially damaging or destroying the large transformers that manage power flow over high-voltage networks.

"Geomagnetically-induced currents on system infrastructure have the potential to result in widespread tripping of key transmission lines and irreversible physical damage to large transformers," a 2009 report (pdf) by the North American Electric Reliability Corp. (NERC) and the Energy Department says.

Agreement on the seriousness of the threat, but not the solution

In the worst-case scenario, the stockpile of spare transformers would fall far short of replacement needs. Urban centers across the continent would be without power for many months or even years, until new transformers could be manufactured and delivered from Asia. The transformers are not made in the United States.

"If the solar storm of 1921, which has been termed a one-in-100-year event, were to occur today, well over 300 extra-high-voltage transformers could be damaged or destroyed, thereby interrupting power to 130 million people for a period of years," Joseph McClelland, director of the Office of Electric Reliability at the Federal Energy Regulatory Commission, said at a May 31 House Energy subcommittee hearing on the issue.

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A Drill to Replace Crucial Transformers (Not the Hollywood Kind)

Scott Dalton for The New York Times

CenterPoint Energy workers installed emergency replacement transformers on Wednesday in Texas City, Tex., near Houston.

By MATTHEW L. WALD
Published: March 14, 2012

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The electric grid, which keeps beer cold, houses warm, and city traffic from turning to chaos, depends on about 2,100 high-voltage transformers spread throughout the country.

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But engineers in the electric business and officials with the Department of Homeland Security have long been concerned that transformers are vulnerable to disruptions from extreme weather like hurricanes, as well as terrorist and computer attacks and even electrical disturbances from geomagnetic, or so-called solar, storms. One such storm, in 1989, blacked out the entire province of Quebec, and this week, a transformer fire of unknown origin blacked out parts of Boston.

And while replacing transformers is not technically difficult, it is a logistical and time-consuming nightmare that can take up to two years.

So this week the industry and the government have been carrying out an emergency drill unlike any that electrical engineers can remember, to explore how quickly the country could recover from a