THE OCEAN AS A MOVING CONDUCTOR: TIDAL MAGNETIC SIGNALS, COASTAL LISTENING ROOMS, AND THE VINDICATION OF FARADAY'S RIVER (ON SABAKA, TYLER AND OLSEN, 2016)

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The Ocean as a Moving Conductor: Tidal Magnetic Signals, Coastal Listening Rooms, and the Vindication of Faraday's River (on Sabaka, Tyler and Olsen, 2016)

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Abstract

In April 2016, Sabaka, Tyler and Olsen reported in Geophysical Research Letters that the Swarm satellites detect the magnetic fields generated by the ocean tides. Seawater is a conductor; as the tides move it through the Earth's magnetic field, electric currents are induced in it, and those currents produce magnetic fields measurable from orbit. In 1832 Faraday tried and failed to detect the same effect in the Thames.

We draw the consequence for listening rooms near the sea. The magnetic field of the principal lunar tide rises and falls twice in every lunar day. We logged the local magnetic field in three coastal listening rooms and one inland reference room over three months, and held paired listening sessions at the extremes of the tidal flow. In the coastal rooms the field varied at the tidal period, and listeners' preferences followed it. In the inland reference room, in Quito, neither did. We recommend that critical listening in coastal installations be scheduled for slack water, and note that the effect is weakest where the vertical component of the Earth's field is small, as the Sociedad Ecuatorial de Quito argued in 1833.

1. INTRODUCTION

In January 1832 Michael Faraday stretched a copper wire from Waterloo Bridge and lowered plates into the Thames, expecting the river, flowing through the magnetism of the Earth, to carry an induced current from bank to bank. He found nothing he could rely on, blamed his plates, and never doubted the principle. The Sociedad Ecuatorial de Quito, writing the following year, agreed with the principle and argued that the effect must vanish where the dipping needle lies level.

The principle has since been confirmed in the oceans, where the conductor is far larger than the Thames. Tyler, Maus and Lühr (2003) identified the magnetic signal of the principal lunar tide in data from the CHAMP satellite. Sabaka, Tyler and Olsen (2016) have now extracted the tidal signals from the first twenty months of the Swarm mission, using the difference between the two lower satellites, which fly side by side, to separate the oceanic signal from other sources. They recovered the principal lunar semidiurnal tide, M2, and the larger lunar elliptic tide, N2.

2. THE MECHANISM

When seawater moves through the geomagnetic field, an electromotive force is induced in it in proportion to its velocity and to the component of the field that its motion cuts. For the broad horizontal flow of the tides, that is chiefly the vertical component of the field. The resulting currents close through the ocean and the seabed and produce a magnetic field that rises and falls with the tide.

The vertical component of the geomagnetic field is largest near the magnetic poles and falls to zero at the magnetic equator. The induced tidal field is correspondingly weakest where the vertical field is weakest. This is the same geometry the Sociedad Ecuatorial de Quito identified in 1833 for a vibrating string, and it has the same consequence: the effect is least near the magnetic equator and greatest far from it.

3. METHOD

Three coastal listening rooms were instrumented, in Guayaquil, Lima and Valparaíso, each within two kilometres of tidal water, together with an inland reference room at this company's facility in Quito, at an altitude of 2,850 metres and some 180 kilometres from the nearest coast. Each room was fitted with a three-axis fluxgate magnetometer, logging the local field every ten seconds from March to May 2016.

In each room, eight listeners took part in paired sessions held at the times of maximum tidal flow and at slack water, as given by tidal-current predictions for each site, comparing the same recordings on the same system without being told the state of the tide. In Quito, sessions were held at the same clock times as in Guayaquil.

4. RESULTS

In all three coastal rooms the magnetometer records showed a variation at the period of the principal lunar tide, 12.42 hours, after the removal of the daily solar variation. The amplitude was smallest in Lima, nearest the magnetic equator, and largest in Valparaíso, farthest from it. In Quito no variation at the tidal period could be distinguished from the noise of the record.

In the coastal rooms, listeners preferred the sessions held at slack water in 61 per cent of paired comparisons; the preference was

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strongest in Valparaíso and weakest in Lima. In Quito the preference was 51 per cent, indistinguishable from chance.

We do not claim that a field of a few nanotesla can be heard. We note that the variation and the preference appeared together, both followed the tide, and both were weakest where the vertical field is weakest and absent inland.

5. RECOMMENDATIONS

Critical listening in coastal installations should be scheduled for slack water, taken from tidal-current predictions for the site and not from the times of high and low water, which at many sites do not coincide with it. Installations within a few kilometres of the sea at high magnetic latitude should be treated as tidal environments in their own right.

The listening room least affected by the ocean is one far from the sea, at altitude, or near the magnetic equator. Quito lies some twelve degrees from the magnetic equator, as this company's founder noted in 2003, but at 180 kilometres from the sea and 2,850 metres above it, the ocean does not reach it. The company's first international customer, in Nairobi, at 1,795 metres and more than 400 kilometres from the sea, is similarly placed.

EDITORIAL NOTE (2026)

This white paper was issued by Neutral Latitude Audio Co., the name under which Dr Magnus Ferro's company traded in 2015 and 2016, and is reproduced from that series. It was the first publication of any of Dr Ferro's companies to cite the proceedings of the Sociedad Ecuatorial de Quito, which he had first cited in his laboratory notes of 2003 and 2006 and which Equatorial Audio has since digitised.

Sabaka, Tyler and Olsen (2016) and Tyler, Maus and Lühr (2003) are real and summarised accurately. Satellite detection of the magnetic signals of the ocean tides is now routine, and they are studied as a measure of the electrical conductivity of the oceans and the mantle beneath them. Faraday's principle, which he could not demonstrate in the Thames, is thus measured from orbit over the whole ocean. The listening study is reproduced as recorded and has not been repeated.

REFERENCES

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