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PITTSBURGH UNIVERSITY GEOLOGY FIELD TRIP
PORTUGAL, MARCH, 8 -17TH 2024



GUIDEBOOK
2024

GEO LOGICA

PITTSBURGH UNIVERSITY PORTUGAL FIELD TRIP

March 8th - 17th, 2024

FROM PANGEIA TO THE ATLANTIC

Douro, Lusitanian & Algarve Basins

Author

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Lisboa

MARCH 2024

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HSE CONTACTS

FIELD TRIP ORGANISERS

Pedro Barreto (Field Trip & HSE Leader/ Instructor /First aider) **+351 913 553 260**

HSE EMERGENCY PHONE NUMBERS

NATIONAL EMERGENCY NUMBER **112**

NORTHERN PORTUGAL

(Day 2 & 3)

Hospital Geral de Santo António (Hospital A&E Facilities) **+351 222 077 500**

Hospital Universitário de S. João (Main Portugal A&E Hospital) **+351 225 512 100**

CENTRAL PORTUGAL

(Day 4 & 5)

Unidade Hospitalar de Leiria (Hospital better A&E Facilities) **+351 244 817 022 (3)**

Unidade Hospitalar de Alcobaça (Hospital A&E Facilities) **+351 262 590 409**

ALGARVE

(Day 5 & 6)

Unidade Hospitalar de Faro (Hospital better A&E Facilities) **+351 289 891 100**

MAIN NATIONAL HEALTH SERVICES PORTUGAL

(Day 7, 8 & 9)

Hospital Santa Maria in Lisboa (Main Portugal A&E Hospital) **+351 217 805 000**

Serviço Nacional de Saude (SNS - Equivelant to NHS) **+351 808 242 424**

1. INTRODUCTION

1.1 PREAMBLE

This guidebook was created by Geo Logica for the undergraduates students attending the University of Pittsburgh at Johnstown Geology Club Portugal Field Trip (March 08th-17th, 2024) entitled "From Pangeia to the Atlantic: Douro, Lusitania and Algarve Basins".

The field trip will take place in Portugal mainland, between March 9th and 17th, 2024, from Porto and the adjacent Douro Valley in the north, passing by the central coastal Portuguese region between Nazaré and Lisbon, to the Algarve region in the South.

Geologically, the field trip will cover the Variscan Central Iberian Zone and Ossa Morena Zone (Porto and Douro), the Meso-Cenozoic Lusitanian Basin (Nazaré to Lisbon), the Variscan South Portuguese Zone (Sagres) and the Meso-Cenozoic Algarve Basin (Albufeira to Loulé).

This field trip highlights are:

- Observe a Variscan Suture Zone in Porto;
- Sail in a traditional boat and visit a winery in Douro Valley to understand the importance of the geology in the local *Terroir*;
- Visit Nazaré to see the spot with the biggest surfable wave in the world (27metres);
- An unique chance to see outcrops with an oil field trapped against a salt diapir (Mina D'Azeche);
- Visit a thermal spa that uses water that flow along and are heated up by a salt diapir;
- Visit the Toarcian GSSP Golden Spike at Peniche;
- Explore the deepest evaporite quarry in Portugal, which was originally a mine near Óbidos;
- Visits the world renowned Praia do Telheiro Unconformity (Paleozoic - Mesozoic - Quaternary) in southwest algarve Coast;
- Boat tour the world famous Benagil Caves in Praia do Carvoeiro, Algarve;
- Visit a salt mine inside a squeezed diapir beneath the centre of Loulé City in Algarve;
- Drive trough the Amazing Sintra Igneous Massif and see its famous castles;
- Go to the most western point of continental Europe, Cabo da Roca;
- Observe the Atlantic Break-up Sequence at Guincho Beach;
- Stay at the city once devastated by one of the biggest earthquakes and tsunamies in history (Lisbon, 1755);
- Discover multiple exceptional outcrops along the coast of Portugal.

1.2 MAIN TOPICS COVERED ON THE FIELD TRIP

- a) Understand the geological history of Portugal from the Variscan orogeny and formation of Pangea to the subsequent opening of the Central and Northern Atlantic Ocean, in the context of the geology of Eastern U.S.A. and Canada;
- b) Recognise on outcrops different lithologies (sedimentary, igneous and metamorphic) and geological structures associated with them;
- c) Recognise on outcrop different tectonic regimes and related deformation (extensional, compressional, inversion and Halokinesis);
- d) Recognise on outcrop the contact between sedimentary and igneous rocks and the metamorphism associated;
- e) Observe on outcrop and understand different types of unconformities;
- f) Observe on outcrop and understand the difference between ductile and brittle deformation;
- g) Observe the Variscan suture/ shear zone that marks the limit between Variscan Central Iberian Zone and Ossa Morena Zone (Porto), which includes 1000 Ma exhumed basalts (now amphibolites) and 600-500 Ma gneisses, lower Paleozoic metasedimentary lithologies, and tardi-Hercynian granites (Foz do Douro, Porto);
- h) Understand the influence of geology in the *Terroir* of Douro Wines, in particular the schists and the granitic intrusions that form the soils and geomorphology where Douro and Port Wines are produced (Douro Valley);
- i) Understand the Wilson Cycle from opening to closure of oceans using the example of Atlantic rifting to the Alpine Orogeny (Lusitanian and Algarve Basins);
- j) Understand initial intracontinental rifting geometries and associated sedimentation;
- k) Understand marine incursions during rifting and associated carbonate and evaporitic sedimentation;
- l) Understand triggering mechanisms and timing of diapirism/ halokinesis and its relation with tectonic events;
- m) Salt diapirism and interaction with sediments: differences and similarities between carbonate and clastic overburden interactions;
- n) Observe the internal structure of diapirs (layered evaporites, volcanic intrusions, interbedded carbonate and clastic sediments, folding, boudinage, faulting and shear zone development in evaporites) and structures around them (unconformities, cap rock formation and dissolution breccias, fault welds and fluid flow along welds);
- o) Observe on outcrop the main elements of petroleum system, from source rock to reservoir rock and trap geometries;

- p) Understand in the field process of continental break up by observing the Atlantic break-up sequence;
- q) Recognise the geometry and structure of magmatic intrusions and extrusions in the field, including CAMP Volcanism and Post-rift magmatism;
- r) Understand the concepts of basin inversion and structural reactivation by observing diagnostic features on outcrop.

1.3 FIELD TRIP CHARACTERISTICS

Field Trip dates: March 8th - 17th, 2024

Start place and time: March 8th - Washington Dulles - The group boards plane to Lisbon.

March 9th: Hotel in Porto (TBD - Porto City Centre/Ribeira) on 09/03/2024 upon arrival to Lisbon airport and train to Porto.

End place and time: Lisbon Airport (LIS) on 17/03/2024 upon transfer and airport departure.

Duration: 10 days (including inbound and outbound travel)

Type: Fieldtrip

Area: Coastal north, central and southern Portugal.

Target audience: Undergraduates and MSc students

Physical requirements: Easy. Participants will be required to walk a maximum of 2 km at some localities over easy relatively flat terrain. The field trip includes boat trips and mine/cave visiting. Participants should inform organisers in case they don't feel comfortable in doing such activities.

Type localities: Coastal and inland outcrops and quarries (active or abandoned), including mine and boat.

Accommodation: Shared Twin/Double bedrooms. 4* Hotel Sé Catedral (Porto, 2 nights) and 4* Your Hotel Alcobaça (Central Portugal, 2 nights), 5* Hotel São Rafael Atlântico Albufeira (Algarve, 2 nights) 4* Hotel Fénix or similar (Lisbon, 2 night).

Meeting Point: Washington Dulles, (U.S.A.) / Hotel in Porto.

Travel methods: 21-seater mini-bus with professional driver (certified tour operated).

Meals: Breakfast at hotels, lunch at restaurants and/or packed lunches, dinner at restaurants.

Included: Transportation (airport transfers + minibus from March 10th to 16th), meals, accommodation in 4 star (6 nights) and 5 Star (2 night) hotels, HSE Guidelines & Risk Mitigation Plan, Field Guide, personal insurance, Personal Protection Equipment (PPE) bag (hard hat, reflective vest, emergency blanket, waterproof whistle) and walking poles (at request).

Number of participants: 16 persons + 1 guide / instructor / first aider.

1.4 LIST OF PARTICIPANTS

1. Ryan Kerrigan - Associate Professor of Geology
2. Jess Kerrigan - Spouse
3. - Professor
4. - Spouse
5. - Professor
6. - Professor
8. - Student
9. - Student
10. - Student
11. - Student
12. - Student
13. - Student
14. - Student
15. - Student
16. - Student

1.5 INSTRUCTOR & GUIDE

Pedro Barreto: Founder of Geo Logica, graduated in Geology from University of Lisbon and MSc in Tectonics, Royal Holloway, University of London. Former Senior Structural Geologist at CGG NPA Satellite Mapping and Senior New Ventures & Exploration Geologist at Partex O&G (Gulbenkian Foundation) where he was Lead Project Geologist for Portuguese exploration. Expert in structural geology from rifting and salt tectonics to compressional settings with research and fieldwork in Portugal, Africa, Middle East and South America. Co-author of several publications and presentations on rifting and salt tectonics. Pedro will act as well as the Field Trip Leader, HSE Leader, First Aider and Traffic Warden.



1.6 FIELD TRIP LOCALITIES SUMMARY

Day 1: Friday (3/8/2024) - Inbound Flight

Day 2: Saturday (3/9/2024) - Porto

Day 3: Sunday (3/10/2024) - Douro Valley & Foz do Douro

Day 4: Monday (3/11/2024) - São Pedro de Moel and Nazaré

Day 5: Tuesday (3/12/2024) - Óbidos & Peniche

Day 6: Wednesday (3/13/2024) - Loulé and Albufeira

Day 7: Thursday (3/14/2024) - Sagres and Portimão

Day 8: Friday (3/15/2024) - Lisbon

Day 9: Saturday (3/16/2024) - Guincho and Sintra

Day 10: Sunday (3/17/2024) - Outbound Flight

1.7 ITINERARY

DAY 1: March 08th (Friday)

Inbound Flight

- The group boards the plane in Washington Dulles to Lisbon

DAY 2: March 09th (Saturday)

Porto

- Lisbon Airport (10:15 am)

- Train to Porto

- Free day in Porto

- Hotel at city centre (Hotel Sé Cathedral Tapestry Collection by Hilton)

(Note: On day 2 only hotel will be provided by Geo Logica. Transfers/Train, lunch and dinner are not included)

DAY 3: March 10th (Sunday)

Douro Valley & Foz do Douro

Sunrise: 06:55h

Sunset: 18:36h

High tide: 02:39 (3.8m) | Low Tide: 08:54 (0.52m) | High tide: 15:05 (3.6m) | Low Tide: 21:07 (0.3m)

08:30 - Drive to Régua via Mesão Frio

10:30 - Winery Visit

12:00 - River boat trip and picnic lunch

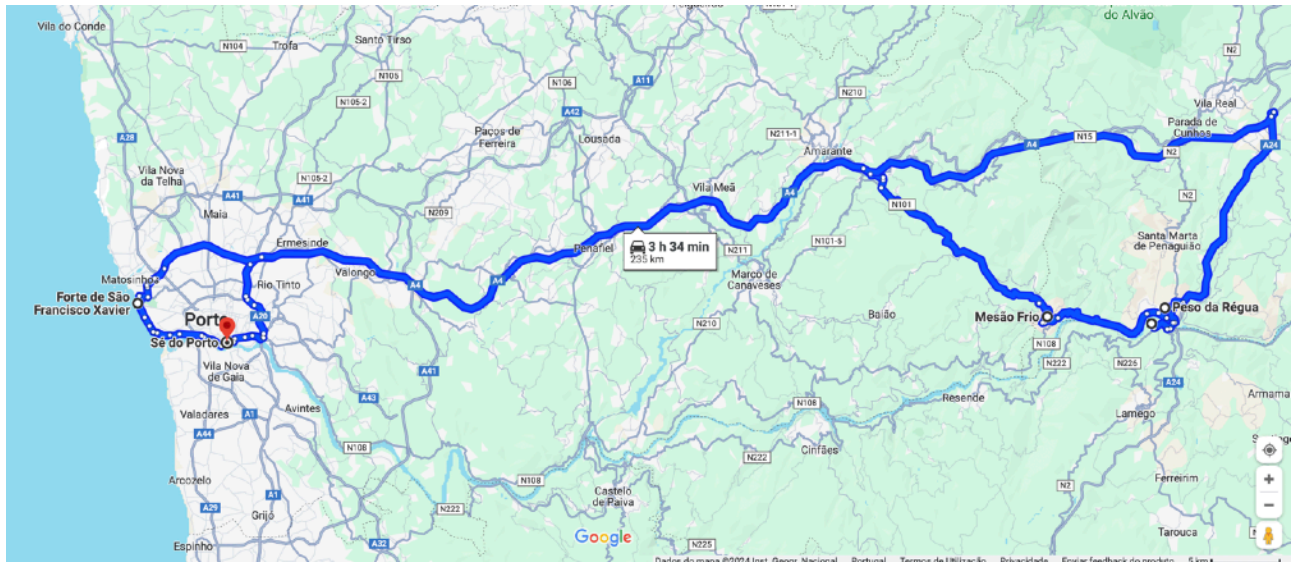
14:00 - Drive to Foz do Douro

16:00 - Foz do Douro Geosite

18:30 - Depart to hotel

19:00 - Hotel at city centre (Hotel Sé Cathedral Tapestry Collection by Hilton)

20:00 - Dinner at Cervejaria Brasão



Maximum continuous driving time: 1:40h ; Total driving time: 4h; Total driving distance: 235 km

DAY 4: March 11th (Monday)

São Pedro de Moel & Nazaré

Sunrise: 06:53h

Sunset: 18:37h

High tide: 03:08 (3.61m) | Low Tide: 09:23 (0.1m) | High tide: 15:33 (3.38m) | Low Tide: 21:36 (0.14m)

07.30 - Drive to Nazaré

10:00 - Mina D'Azeche oil field cliff section

12:00 - Senhora da Vitória headland section

13:00 - Lunch at Somar (Paredes de Vitória)

14:30 - Pedras Negras Section

15:30 - Praia da Concha Section

16:30 - Drive to Nazaré Promontory

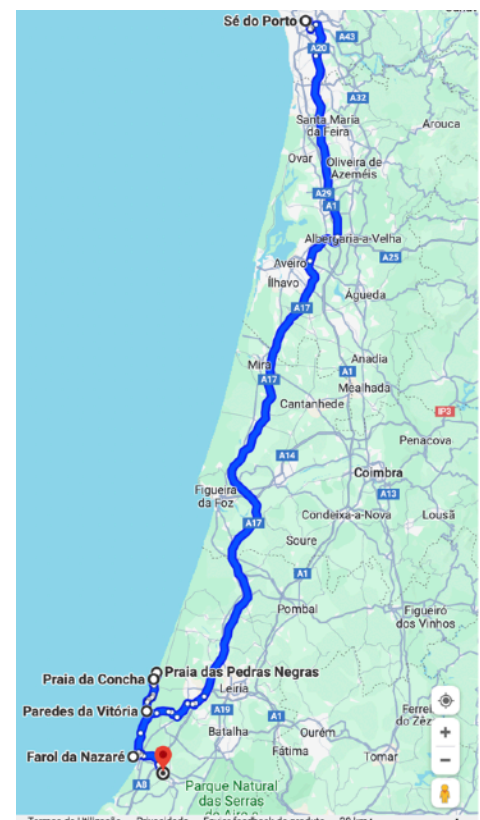
17:00 - Promontory Nazaré Promontory

18:30 - Drive to hotel

19:00 - Your Hotel in Alcobaça

20:30 - Dinner at Alcobaça (António Padeiro)

Maximum continuous driving time: 2:30h (including 15 minutes resting time);
Total driving time: 4h; Total driving distance: 250 km



DAY 5: March 12th (Tuesday)

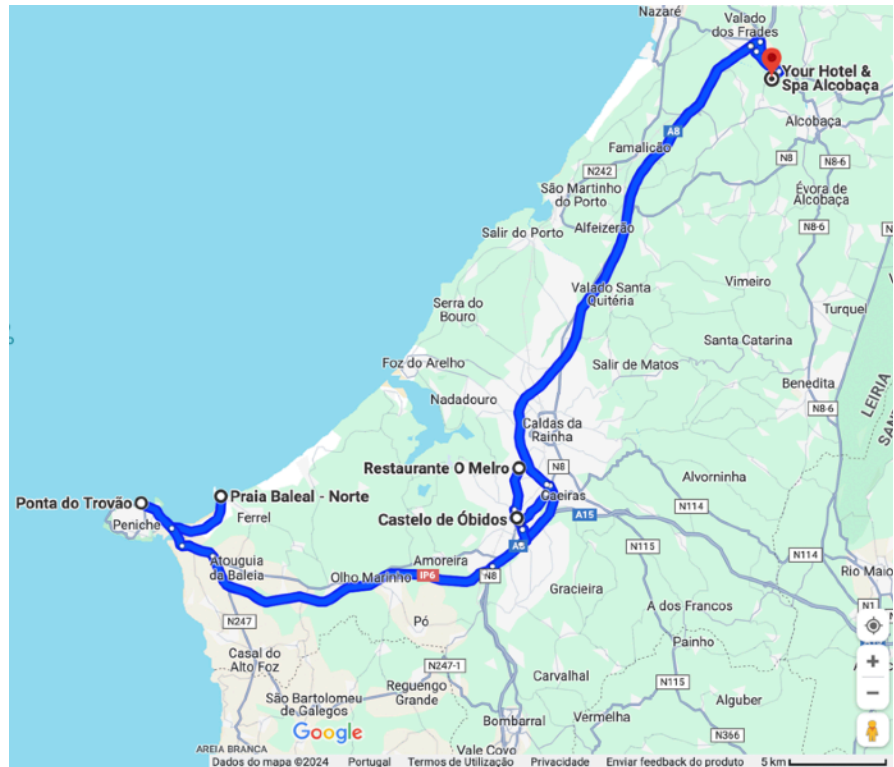
Óbidos & Peniche

Sunrise: 06:52h

Sunset: 18:38h

High tide: 03:51 (3.8m) | Low Tide: 10:03 (0.15m) | High tide: 16:14 (3.54m) | Low Tide: 22:16 (0.28m)

- 09:00 - Depart to Óbidos
- 10:00 - Baleal Section
- 11:00 - Peniche section
- 12:30 - Depart Peniche
- 13:00 - Lunch (O Melro)
- 14:00 - SOGERELA mine
- 16:00 - Depart SOGERELA Mine
- 16:30 - Óbidos Castle outcrops
- 18:00 - Depart Óbidos
- 18:30 - Hotel (Your Hotel)
- 19:00 - Thermal SPA
- 20:30 - Dinner at Hotel



Maximum continuous driving time: 1h ; Total driving time: 2:30h; Total driving distance: 135 km

DAY 6: March 13th (Wednesday)

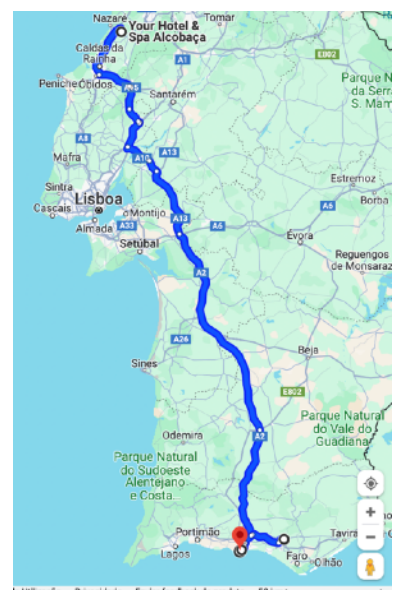
Loulé & Albufeira

Sunrise: 06:50h

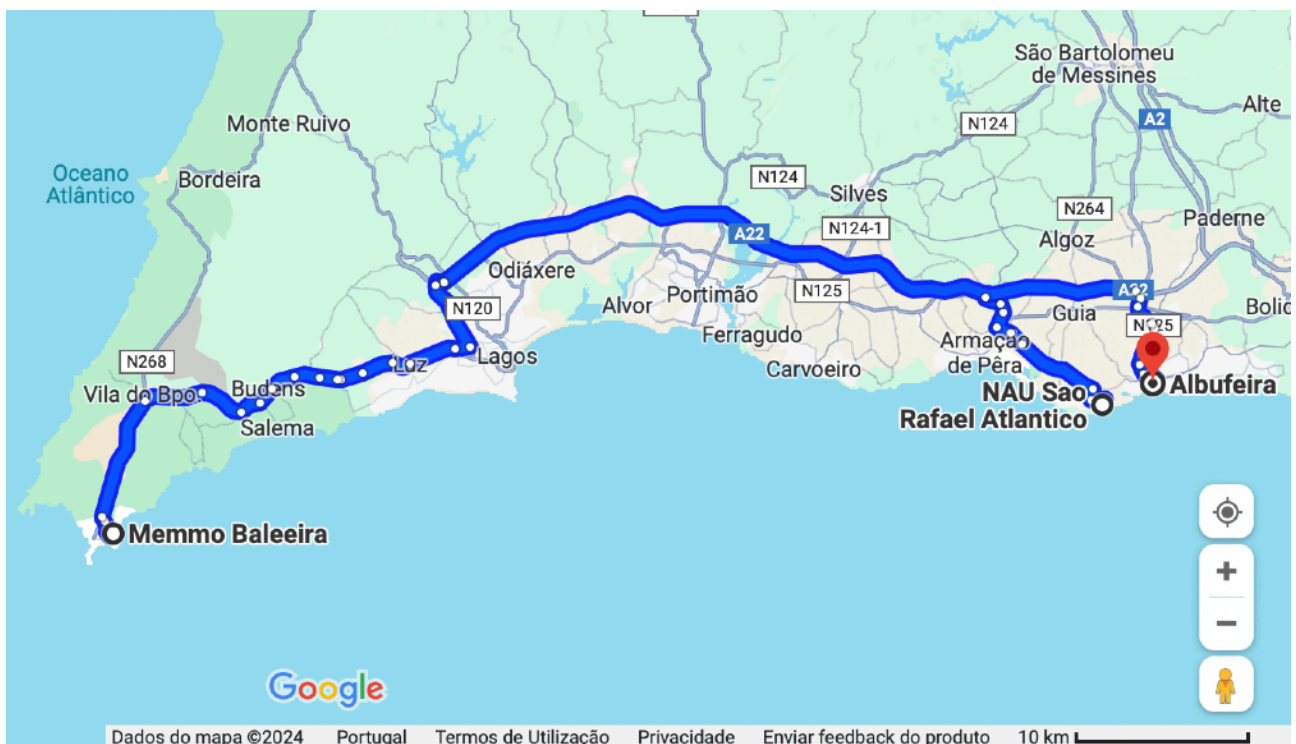
Sunset: 18:39h

High tide: 04:06 (3.45m) | Low Tide: 10:15 (0.26m) | High tide: 18:28 (3.21m) | Low Tide: 22:32 (0.35m)

- 08:30 - Drive to Algarve (4h w/ 15 minutes resting time).
- 12:30 - Lunch at Loulé (Churrasqueira Leonel)
- 14:00 - Tech Salt Mine (Loulé).
- 16:00 - Depart Tech Salt Mine
- 17:00 - Arrival to Praia do Baleal - Albufeira Diapir.
- 18:20 - Depart Praia do Baleal
- 18:30 - Arrival to Hotel Nau São Rafael Atlântico.
- 20:00 - Dinner at Praia dos Arrifes (O sardinha)



Maximum continuous driving time: 4h (including 15 minutes resting time); Total driving time: 4:45h; Total driving distance: 400 km

DAY 7: March 14th (Thursday)**Sagres & Portimão****Sunrise: 06:48h****Sunset: 18:41h****High tide: 04:53 (3.17m) | Low Tide: 10:59 (0.51m) | High tide: 17:13 (2.98m) | Low Tide: 23:20 (0.58m)****09:00** - Drive to Sagres**10:30** - Boat cruise (Catamaran) from Sagres to Praia do Telheiro Unconformity**12:30** - Lunch at Sagres**13:30** - Drive to Albufeira**15:00** - Boat Trip (speed raft) from Albufeira to Benagil Cave**17:00** - Return to Hotel S. Rafael Atlântico in Albufeira**20:00** - Dinner at Hotel**Maximum continuous driving time: 1:30h; Total driving time: 3:00h; Total driving distance: 170 km****DAY 8: March 15th (Friday)****Drive to Lisbon****Sunrise: 06:47h****Sunset: 18:42h****09:30** - Drive to Lisbon**13:00** - Arrive at Stay at Hotel Fenix in Lisbon. Free afternoon at Lisbon.**20:00** - Dinner at Lost In Restaurant**Maximum continuous driving time: 3:30h (including 15 minutes resting time); Total driving time: 3:30h; Total driving distance: 260 km**

DAY 9: March 16th (Saturday)**Guincho & Sintra**

Sunrise: 06:45h

Sunset: 18:44h

Low Tide: 00:26 (1.15m) | High tide: 06:48 (2.88m) | Low Tide: 12:48 (1.35m) | High tide: 19:14 (2.85m)

09:30 - Drive to Peninha

10:30 - Peninha

11:30 - Praia da Cresmina

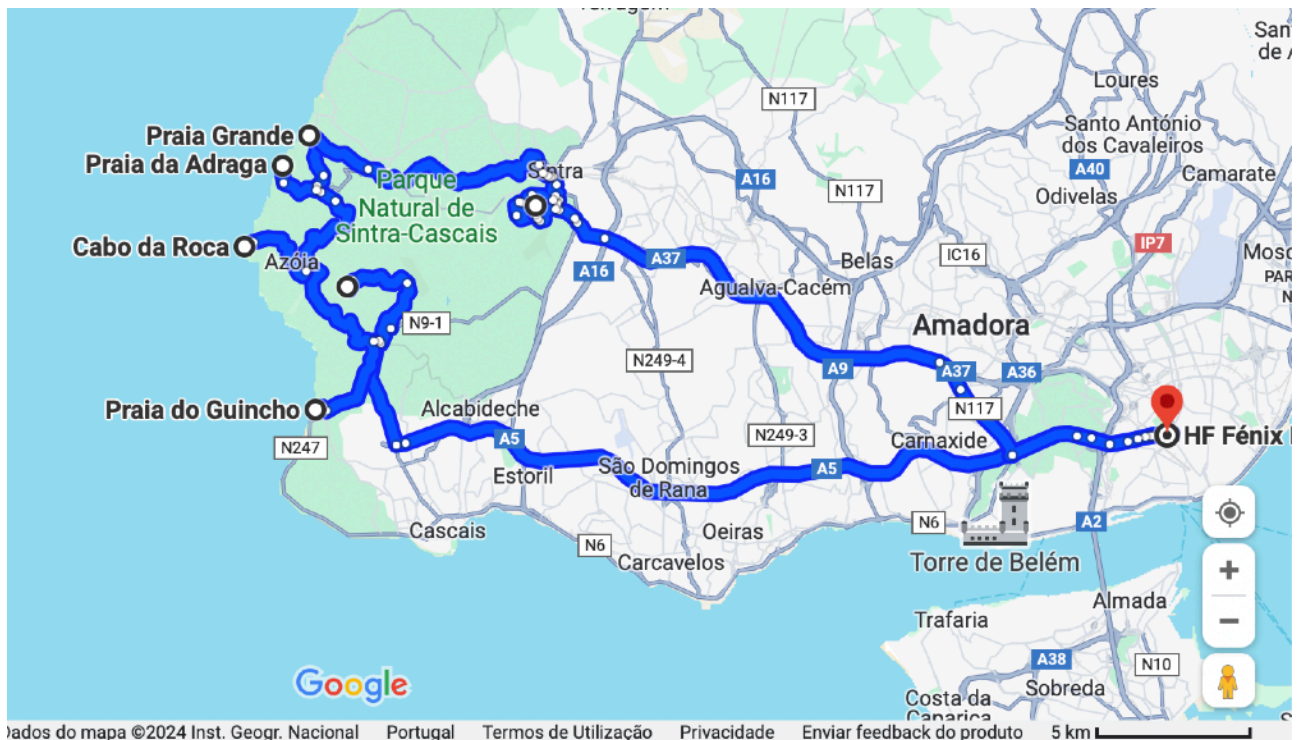
12:30 - Cabo da Roca

13:00 - Praia da Adraga

14:30 - Praia Grande Do Rodízio

16:30 - Drive by Sintra (Castelo dos Mouros, Palácio da Pena)

18:00 - Hotel Fenix in Lisbon



Maximum continuous driving time: 1h ; Total driving time: 3:30h; Total driving distance: 115 km

DAY 10: March 17th (Sunday)**Outbound Flight**

- Hotel-Airport transfer
- Flight (10:55 am)

