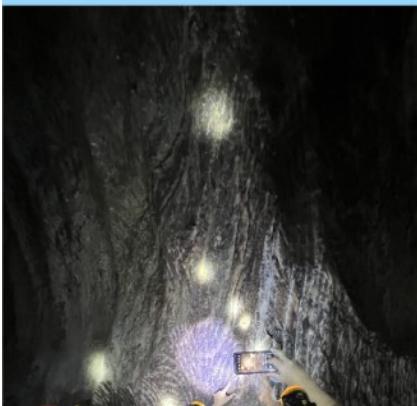




# Geo Logica<sup>©</sup>

a planet in constant change

PITTSBURGH UNIVERSITY GEOLOGY FIELD TRIP  
PORTUGAL, MARCH, 8 -17<sup>TH</sup> 2024



GUIDEBOOK  
2024

# **GEO LOGICA**

## **PITTSBURGH UNIVERSITY PORTUGAL FIELD TRIP**

March 8<sup>th</sup> - 17<sup>th</sup>, 2024

### **FROM PANGEIA TO THE ATLANTIC**

#### **Douro, Lusitanian & Algarve Basins**

Author

**Pedro Barreto**

**Lisboa**

**MARCH 2024**

## TABLE OF CONTENTS

HSE CONTACTS	4
1. INTRODUCTION	5
1.1 PREAMBLE.....	5
1.2 MAIN TOPICS COVERED ON THE FIELD TRIP .....	6
1.3 FIELD TRIP CHARACTERISTICS.....	7
1.4 LIST OF PARTICIPANTS .....	8
1.5 INSTRUCTOR & GUIDE .....	8
1.6 FIELD TRIP LOCALITIES SUMMARY .....	9
1.7 ITINERARY.....	9
Day 1: March 08th (Friday)                   Inbound Flight .....	9
Day 2: March 09th (Saturday)                   Porto .....	9
Day 3: March 10th (Sunday)   Douro Valley & Foz do Douro .....	9
Day 4: March 11th (Monday)   São Pedro de Moel & Nazaré .....	10
Day 5: March 12th (Tuesday)   Óbidos & Peniche.....	11
Day 6: March 13th (Wednesday)   Loulé & Albufeira .....	11
Day 7: March 14th (Thursday)   Sagres & Portimão.....	12
Day 8: March 15th (Friday)   Drive to Lisbon .....	12
Day 9: March 16th (Saturday)   Guincho & Sintra.....	13
Day 10: March 17th (Sunday)   Outbound Flight .....	13

Copyright @ Geo Logica<sup>®</sup> 2024  
All rights reserved

This publication is in copyright. All the content of this document, unless where referenced otherwise, including images, text and any other media included in this document is intellectual property of Geo Logica<sup>®</sup> and protected by copyright law.  
No reproduction of any part may take place without written permission of Geo Logica<sup>®</sup>.

## 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 National 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 08<sup>th</sup>-17<sup>th</sup>, 2024) entitled "From Pangeia to the Atlantic: Douro, Lusitania and Algarve Basins".

The field trip will take place in Portugal mainland, between March 9<sup>th</sup> and 17<sup>th</sup>, 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 8<sup>th</sup> - 17<sup>th</sup>, 2024

**Start place and time:** March 8<sup>th</sup> - Washington Dulles - The group boards plane to Lisbon.

March 9<sup>th</sup> : 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 08<sup>th</sup> (Friday)

**Inbound Flight**

- The group boards the plane in Washington Dulles to Lisbon

### DAY 2: March 09<sup>th</sup> (Saturday)

**Porto**

- Lisbon Airport (10:15 am)

- Train to Porto

- Free day in Porto

- Hotel at city centre (Hotel Sé Catedral 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 10<sup>th</sup> (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

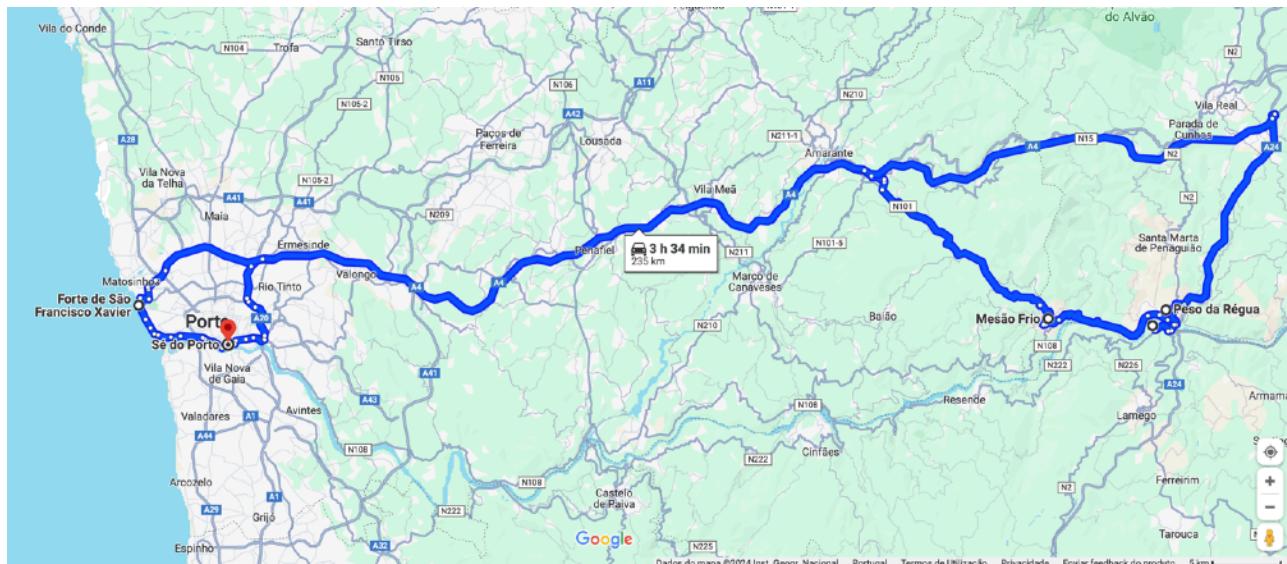
**14:00** - Drive to Foz do Douro

**16:00** - Foz do Douro Geosite

**18:30** - Depart to hotel

**19:00** - Hotel at city centre (Hotel Sé Catedral 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 11<sup>th</sup> (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

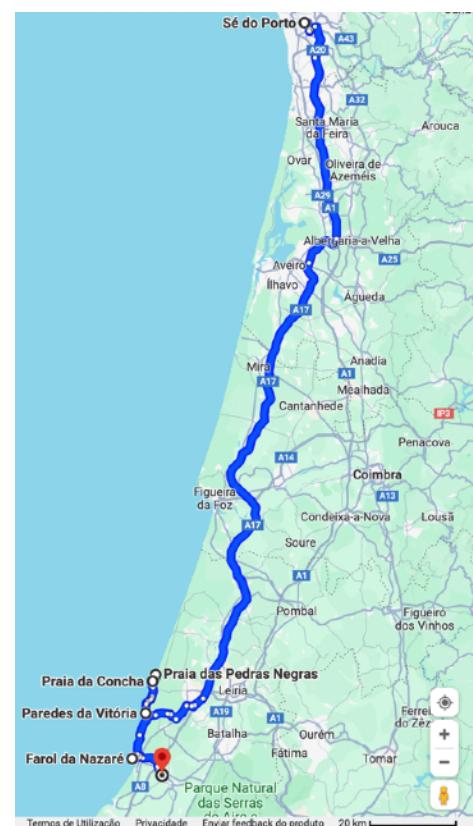
**16:30** - Drive to Nazaré Promontory

**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 12<sup>th</sup> (Tuesday)**

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

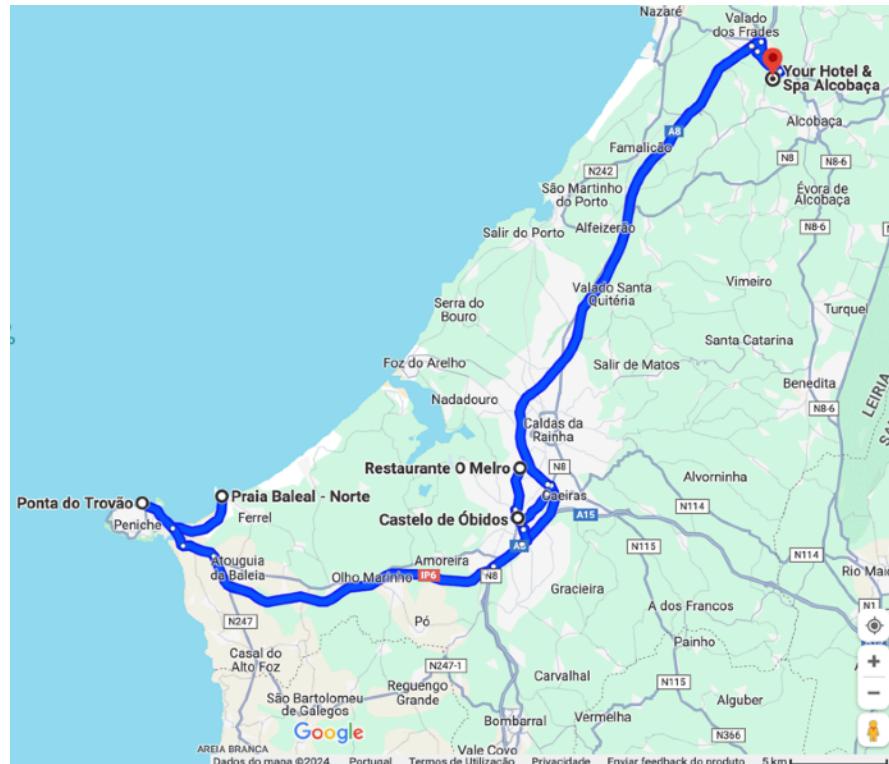
16:30 - Óbidos Castle outcrops

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 13<sup>th</sup> (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).

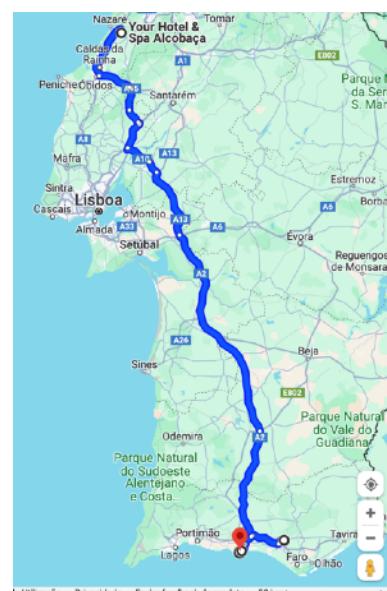
16:00 - Depart Tech Salt Mine

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)

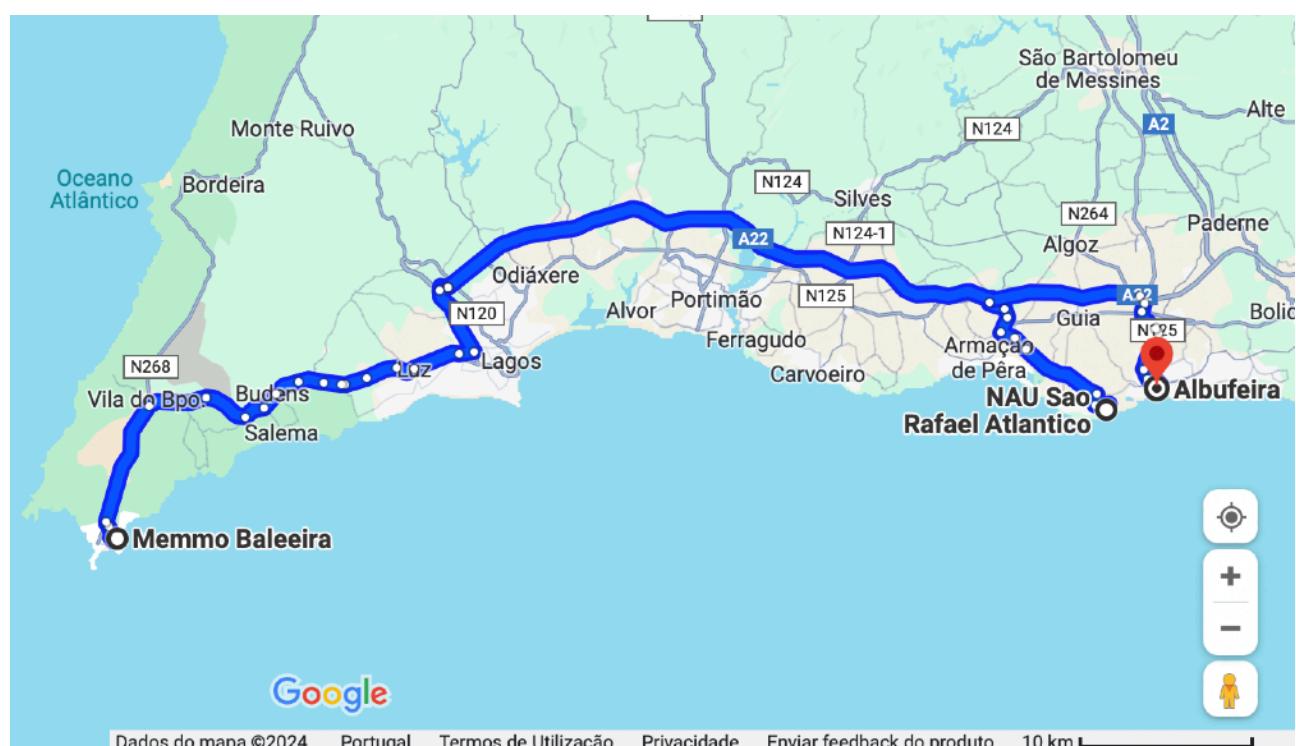


Maximum continuous driving time: 4h (including 15 minutes resting time); Total driving time: 4:45h; Total driving distance: 400 km

**DAY 7: March 14<sup>th</sup> (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 15<sup>th</sup> (Friday)****Drive to Lisbon**

Sunrise: 06:47h

Sunset: 18:42h

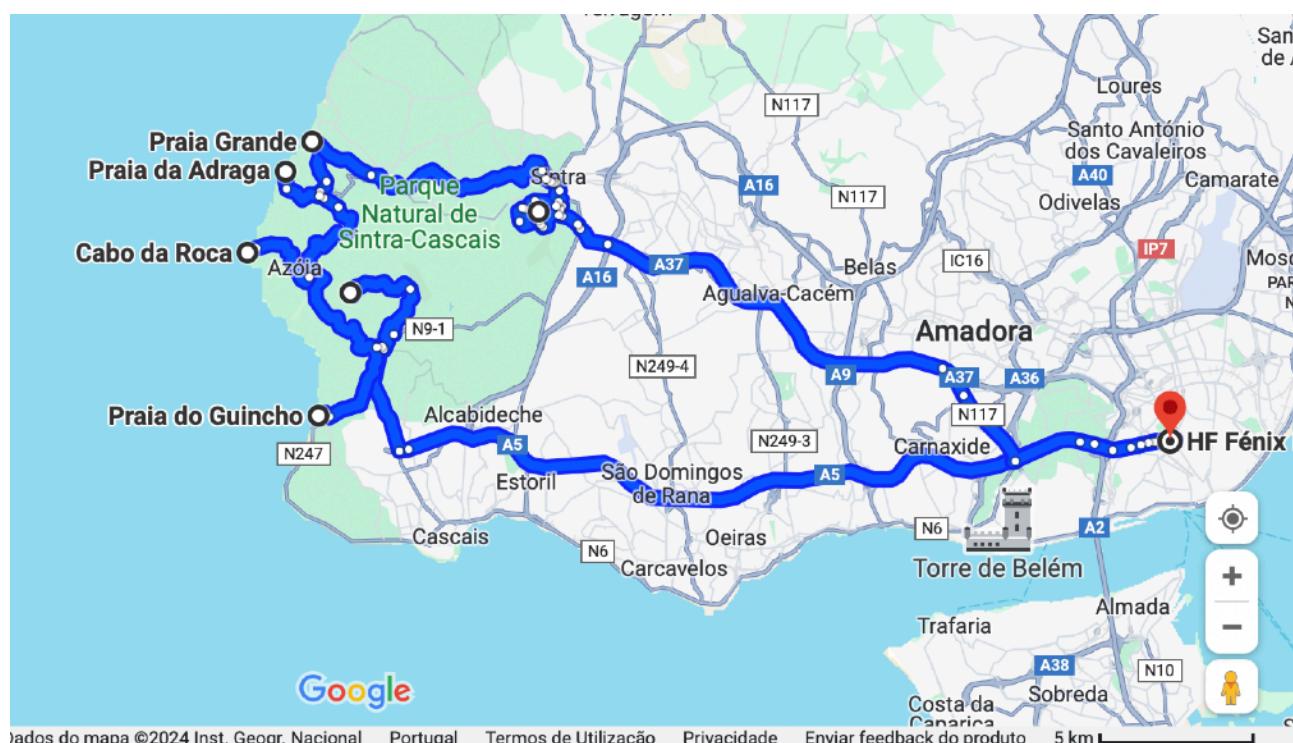
**09:30** - Drive to Lisbon**13:00** - Arrive at Stay at Hotel Fenix in Lisbon. Free afternoon at Lisbon.**20:00** - Dinner at Lost In Restaurant

Maximum continuous driving time: 3:30h (including 15 minutes resting time); Total driving time: 3:30h; Total driving distance: 260 km

**DAY 9: March 16<sup>th</sup> (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)

