Map Showing Geology, Oil and Gas Fields, and Geologic Provinces of Europe including Turkey

Compiled by Mark J. Pawlewicz\textsuperscript{1}, Douglas W. Steinshouer\textsuperscript{3} and Donald L. Gautier\textsuperscript{2}

Open File Report 97-470I

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade names is for descriptive purposes only, and does not imply endorsement by the U.S. government.

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Map Showing Geology, Oil and Gas Fields, and Geologic Provinces of Europe including Turkey

Table of Contents

Preface

Introduction

Data Processing Steps

Primary References

Geologic Provinces of Europe including Turkey, Sorted by Province Name

Index Map of Europe including Turkey

Explanation of Geologic Age Units

Map Showing Geologic Provinces, and Oil and Gas Fields of Europe including Turkey

Map Showing Geology, Oil and Gas Fields, and Geologic Provinces of Europe including Turkey

Charts Depicting Petroleum Resource Endowment of Geologic Provinces in Europe including Turkey Assessed by the U.S. Geological Survey's World Energy Team.
PREFACE

This is one of a series of products resulting from the World Energy Project of the U.S. Geological Survey. Inquiries about this CD-ROM or the Project's effort in the European Region should be addressed to:

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Attribution of geologic outcrops: Mark J. Pawlewicz and Douglas W. Steinshouer
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Map layout design: Douglas W. Steinshouer
CD-ROM implementation and design: Douglas W. Steinshouer and Kenneth I. Takahashi
Metadata: Douglas W. Steinshouer
Coordination: Donald L. Gautier
INTRODUCTION

This digitally compiled map includes geology, geologic provinces, and oil and gas fields of Europe including Turkey. The maps are part of a worldwide series of maps on CD-ROM released by the U.S. Geological Survey's World Energy Project. The goal of the project is to assess the undiscovered, technically recoverable oil and gas resources of the world. For data management purposes the world was divided into eight energy regions corresponding approximately to the economic regions of the world as defined by the U.S. Department of State. Europe (Region 4) includes Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, The Former Yugoslav Republic of Macedonia, Malta, Monaco, Netherlands, Norway, Poland, Portugal, Romania, San Marino, Serbia and Montenegro, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom and Vatican. The depicted portion of Region 2 includes Turkey.

Each region is divided into geologic provinces. Each province has a set of geologic characteristics that distinguish it from surrounding provinces. These characteristics may include the predominant lithologies, the age of the strata, and the structural style. Some provinces include multiple genetically-related basins. Geologic province boundaries are delineated using data from a number of geologic maps and other tectonic and geographic data (see References). Offshore province boundaries are defined by the 2000 meter bathymetric contour. Each province is assigned a unique number. Because geologic trends are independent of political boundaries, some provinces overlap two regions. The code of those provinces that lie entirely within Europe begin with the number 4 and those provinces that lie entirely within Turkey begin with the number 2. The code of those provinces that lie partly within another region may start with a 1, for the Former Soviet Union (Persits and others 1998) or a 2, for Middle East and North Africa (Pollastro, 1998; Persits and others, 1997).

The centerpoint locations of oil and gas fields are plotted based on the locations in the Petroconsultants International Data Corp. (1996) database with permission. Selected provinces are currently being investigated, by Total Petroleum System analysis, and assessments are being made of the undiscovered oil and gas resource potential of these provinces. Klett and others (1997) discuss the worldwide geologic provinces and their relative ranking in terms of total known petroleum volume. Specific details of the data sources and map compilation are given in the metadata files on this CD-ROM. Some stratigraphic units are combined to simplify the map and to ensure consistency across the region. All rocks are colored by age. Igneous and metamorphic rocks are identified with fill patterns and colors.

These maps are compiled using Environmental Systems Research Institute Inc. (ESRI) ARC/INFO software. Political boundaries and cartographic representations on this map are taken, with permission from ESRI's ArcWorld 1:3M digital coverage; they have no political significance and are displayed as general reference only. Portions of this database covering the coastline and country boundaries contain intellectual property of ESRI. (© 1992 and 1996, Environmental Systems Research Institute Inc. All rights reserved.)
DATA PROCESSING STEPS

The maps on this CD were digitally compiled and abstracted from:
International Geological Map of Europe and the Mediterranean Region/
Carte Geologique de l'Europe et des regions riveraines de la Mediterranee, 1971
H. -R. von Gaertner
Scale 1:5,000,000
2 sheets
http://www.unesco.org/general/eng/index.html

The following process steps were taken:

1. UNESCO/CGMW source map sheets were scanned, registered and rectified using ESRI Arcworld 1:3M shorelines as reference.

2. Using scanned map images as a backdrop, geologic contacts and faults were digitized, and geologic age polygon labels were attributed in Arc/INFO arcedit using an AML menu interface.

3. The map sheets were produced using Arcmap. The Adobe Portable Document Format was created using the Acrobat Distiller print option in Arcmap.

4. The ArcExplorer and Arcview projects were created with shapefiles produced from the Arc/INFO coverages. Avenue scripts were written to customize the Arcview project for ease of use and maximum performance with large data sets.
PRIMARY REFERENCES

Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000.


Petroconsultants International Data Corp., 1996, Petroleum exploration and production database: Petroconsultants International Data Corp.

**Provinces assigned to Europe including Turkey, sorted by name**

<table>
<thead>
<tr>
<th>Province</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adana/Sivas</td>
<td>2079</td>
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<tr>
<td>Adriatic Basin</td>
<td>4058</td>
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<tr>
<td>Aegean</td>
<td>4075</td>
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<tr>
<td>Alentejo-Guadalquivir Basin</td>
<td>4077</td>
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<td>Alps</td>
<td>4051</td>
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<td>4088</td>
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<td>4036</td>
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<tr>
<td>Anglo-Paris Basin</td>
<td>4040</td>
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<tr>
<td>Apulia Platform</td>
<td>4059</td>
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<tr>
<td>Aquitaine Basin</td>
<td>4045</td>
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<tr>
<td>Araks</td>
<td>2080</td>
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<td>4041</td>
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<td>4021</td>
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<tr>
<td>Bresse Depression</td>
<td>4054</td>
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<td>Carpathian-Balkanian Basin</td>
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<td>Corsican-Sardinian Basins</td>
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<td>Crete</td>
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<td>Dinaric Alps</td>
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<td>Dobrogean Orogen</td>
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<td>Faeroes-Shetland-Orkney Basin</td>
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<td>Fennoscandian Border-Danish-Polish Margin</td>
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<td>Galician Basin</td>
<td>4073</td>
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<tr>
<td>German-Polish Basin</td>
<td>4033</td>
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<td>Hammerfest-Varanger Basin</td>
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<td>Hatton-Rockall Basin</td>
<td>4020</td>
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<td>Horda-Norwegian-Danish Basin</td>
<td>4023</td>
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<td>Iberian Massif</td>
<td>4072</td>
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<tr>
<td>Iberic Cordillera</td>
<td>4083</td>
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<td>Ireland-Scotland Platform</td>
<td>4026</td>
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<tr>
<td>Irish Sea</td>
<td>4030</td>
</tr>
</tbody>
</table>
Jura 4052
Kardiff/Menders Massif 2084
Lesser Caucasus 2081
Lion-Camargue 4056
London-Brabant Platform 4037
Lusitanian Basin 4074
Massif Central 4043
Midland Valley-Forth Approaches Basin 4027
Mid-North Sea High 4028
Molasse Basin 4049
Munsterland Basin 4038
North Carpathian Basin 4047
North Sea Graben 4025
Northwest German Basin 4035
Pannonian Basin 4048
Po Basin 4060
Provence Basin 4068
Pyrenean Foothills-Ebro Basin 4044
Rhine Graben 4055
Sicily 4066
Southwest German Basin 4039
Spanish Trough-Cantabrian Zone 4070
Tajo-Duero Basin 4082
Thrace/Samsun 2085
Trans-graben 4053
Transylvania 4057
Troms-Bjornoya Basin 4014
Tuscany-Latium-Paola 4062
Tuz/Corum 2083
Tyrrenhian Basin 4069
Vestford-Helgeland 4017
West Black Sea Basin 4064
Provinces assigned to other regions, sorted by name

Belorussian-Voronezh High   1004
Black Sea Continental Slope 1107
Dobrogea Foreland           1103
Euphrates/Mardin             2075
Haleb                        2076
Kola Monocline-Finnmark Platform 1051
Mediterranean Basin         2070
Pelagian Basin               2048
Rif Basin                    2072
Russian Craton Margin        1011
Ukrainian Shield             1013
Zagros Fold Belt             2030
Zagros Thrust Zone           2031
Index map of the area depicted in
Map Showing Geology, Oil and Gas Fields, and Geologic Provinces of Europe including Turkey
EXPLANATION OF MAP UNITS AND SYMBOLS

SEDIMENTARY ROCK UNITS

- Neogene
- Paleogene
- Cretaceous
- Jurassic
- Triassic
- Permian
- Carboniferous
- Devonian
- Silurian
- Ordovician
- Cambrian

IGNEOUS AND METAMORPHIC ROCK UNITS

- Quaternary volcanic rocks
- Tertiary volcanic rocks
- Undifferentiated volcanic rocks
- Undifferentiated intrusive rocks
- Amphibolites of undetermined age

OTHER MAP UNITS

- Water less than 200 meters in depth
- Water between 200 and 1000 meters in depth
- Water between 1000 and 3000 meters in depth
- Water between 3000 and 5000 meters in depth
- Water greater than 5000 meters in depth
- Glacial ice
- Unmapped area

- Oil field center point
- Gas field centerpoint

- Geologic contact
- Fault
- Inferred fault
- Thrust fault
- Inferred thrust fault
- Bathymetric depth contour
  depth in meters indicated by blue numeral

- Geologic province boundary
  province code indicated by red numeral

- Political boundary

- Selected capital or major city

- Line of latitude or longitude,
  two degree interval
The digitally compiled map is part of a worldwide series of maps on CD-ROM released by the U.S. Geological Survey’s World Energy Project. The goal of this project is to create a standardized, technically accurate set of maps in support of international energy policy and planning. For this management program, the world was divided into eight energy regions based on political boundaries and corresponding approximately to the economic regions of the world. The regions are defined by the 2000 meter bathymetric contour. Each province is assigned a unique number. Because geologic trends are independent of political boundaries, some provinces overlap two regions and two or more countries. Details of the data sources and map compilations are given in the metadata files on the CD-ROM.

REFERENCES

Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.

Bjorneboe, S., and others, 1993, Line of latitude or longitude, including any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

The map is preliminary. Environmental Systems Research Institute, Inc. (ESRI) and ESRI software.

Any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

Environment Canada, 1991, Line of latitude or longitude, including any use of trade names is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.


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The region is divided into geologic provinces (Klett and others, 1997). Each province has a set of geologic characteristics that distinguish it from other provinces. The provinces are used to map the petroleum and natural gas resources of the world. The provinces are defined with generalization of the level of data available. Many provinces are places where the geology has been studied extensively, and others are so named for their correspondence to other provinces or political boundaries. The provinces are independent of political boundaries.

Because geologic trends are independent of political boundaries, some provinces overlap two regions and two or more countries. The province code indicated by red numeral (

1. Oil field center point

2. Oil field center point

3. Political boundary

4. Geologic province boundary,

5. Geologic province assessed in

6. Geologic province assessed in

7. Geologic province assessed in


9. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


11. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


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15. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


17. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


19. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


21. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


23. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


25. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


27. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


29. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


31. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


33. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


35. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


37. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


39. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


41. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.


43. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.

44. Petroconsultants International Data Corp., 1996, Petroleum Exploration and Production Database: Petroconsultants International Data Corp.

45. Environmental Systems Research Institute, Inc. (ESRI), 1992, Arcworld Digital Map of the World: ESRI, scales 1:3,000,000 and 1:25,000,000, CD-ROM.

Geographical distribution of the petroleum resource endowment of geologic provinces in Europe including Turkey

Cumulative production is the amount of oil, natural gas, or natural gas liquids produced from the oil and gas fields in each province assessed by the U.S. Geological Survey. Remaining reserves constitute the sum of proved plus probable reserves of oil, gas, or natural gas liquids present in oil and gas fields within each province. These volumes are from the proprietary Petroconsultants database, current through 1995. (Petroconsultants, 1996) and are presented here with permission. The mean values of undiscovered oil, natural gas, and natural gas liquids amounts presented here are aggregated at the geologic province level (U.S. Geological Survey Assessment Team, 2000). Definitions of oil, natural gas, and natural gas liquids are those used in the World Petroleum Assessment, 2000. Petroleum is considered to include oil, natural gas, and natural gas liquids, and is reported on a barrel of oil equivalents (BOE) basis, where 6000 cubic feet of gas equals one barrel equivalent. Oil and natural gas liquids resources are reported in millions of barrels (MMBO and MMBNGL). Natural gas is reported in billions of cubic feet of gas (BCF).