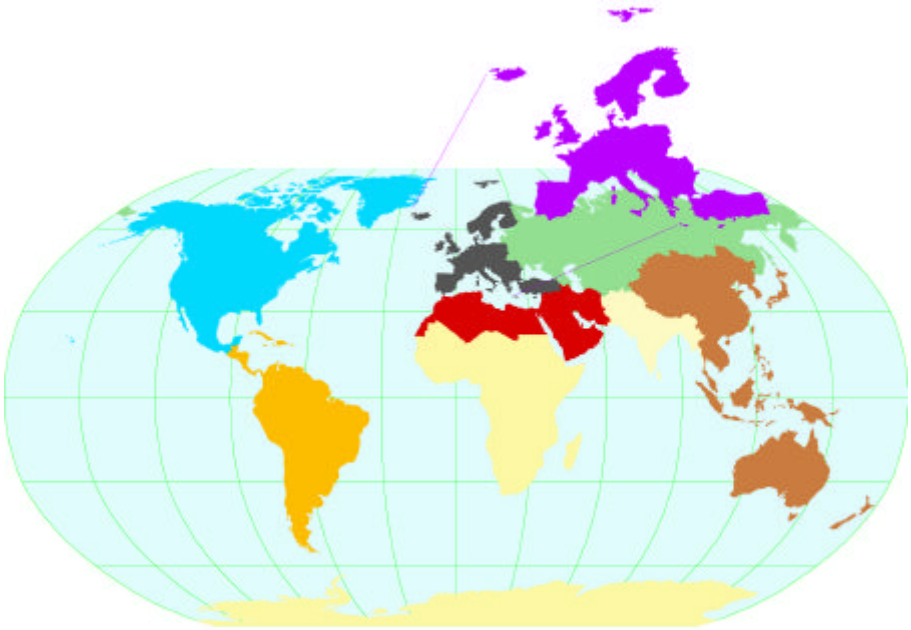
U.S. Department of the Interior
U.S. Geological Survey

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

Compiled by Mark J. Pawlewicz[1], Douglas W. Steinshouer[3] and Donald L. Gautier[2]

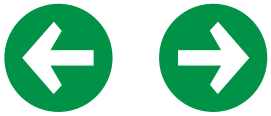


Open File Report 97-470I

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.

[1] U.S. Geological Survey, MS 939, Box 25046, Denver, CO 80225
[2] U.S. Geological Survey, MS 975, Menlo Park, CA 94025
[3] Contractor to the U.S.G.S., MS 939, Box 25046, Denver, CO 80225

USGS
science for a changing world



U.S. Geological Survey Open File Report 97-470I

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

Table of Contents

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:

Donald L. Gautier (Coordinator, European region)
U.S. Geological Survey
345 Middlefield Road, MS 975
Menlo Park, CA 94025
Tel: (650) 329-4909
Email: gautier@usgs.gov

Inquiries about the World Energy Project's efforts in the Turkey region should be directed to:
Thomas S. Ahlbrandt (Coordinator, Middle East and North Africa region)
U.S. Geological Survey
Box 25046
Denver Federal Center
Denver, CO 80225
Tel: (303) 236-5776
Email: ahlbrandt@usgs.gov

Inquiries about the U.S. Geological Survey's World Energy Project should be directed to:
Thomas S. Ahlbrandt (Coordinator, World Energy Project)
U.S. Geological Survey
Box 25046
Denver Federal Center
Denver, CO 80225
Tel: (303) 236-5776

The authors of the CD were responsible for the following aspects of producing the maps:

Compilation of geologic outcrops: Mark J. Pawlewicz and Douglas W. Steinshouer
Attribution of geologic outcrops: Mark J. Pawlewicz and Douglas W. Steinshouer
Designation of geologic provinces:
Donald L. Gautier, Thomas S. Ahlbrandt, Gordon L. Dolton and Mark J. Pawlewicz
GIS input and manipulation:
Douglas W. Steinshouer and Mark J. Pawlewicz
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

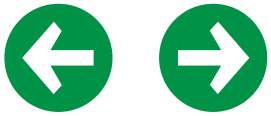
INTRODUCTION

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 of the world as defined by the U.S. Department of State. Europe (Region 4) includes Albania, Andorra, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, 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.



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
UNESCO, Commission for Geological Map of the World, (UNESCO/CGMW)
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.

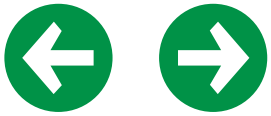
Gaertner, H. -R. v., Walther, H.W., Weber, H.S., and Voss, H.-H., 1971,
International Geological Map of Europe and the Mediterranean Region/
Carte Geologique de l'Europe et des regions riveraines de la
Mediterranee: United Nations Educational, Scientific and Cultural
Organization (UNESCO) and Commission for Geological Map of the
World (CGMW), 2 sheets, scale 1:5,000,000.

Klett, T.J., Ahlbrandt, T.S., and Dolton, G.L., 1997,
Ranking of World's Oil and Gas Provinces by Known Petroleum
Volumes: U.S. Geological Survey Open File Report 97-463,
one CD-ROM.

Klett, T.J., Schmoker, J.W., and Ahlbrandt, T.S., 2000,
Assessment hierarchy and initial province ranking: *in* U.S. Geological
Survey World Energy Assessment Team, U.S. Geological Survey World
Petroleum Assessment 2000 - Description and Results: U.S. Geological
Survey Digital Data Series DDS 60, 4 CD-ROMs.

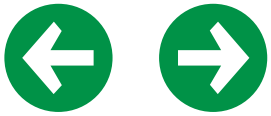
Petroconsultants International Data Corp., 1996,
Petroleum exploration and production database:
Petroconsultants International Data Corp.

U.S. Geological Survey World Energy Assessment Team, 2000,
U.S. Geological Survey World Petroleum Assessment 2000-
Description and Results: U.S. Geological Survey Digital Data Series
DDS 60, 4 CD-ROMs.

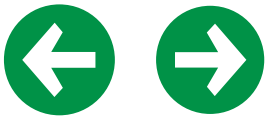


Provinces assigned to Europe including Turkey, sorted by name

Adana/Sivas	2079
Adriatic Basin	4058
Aegean	4075
Alentejo-Guadalquivir Basin	4077
Alps	4051
Andalucia	4088
Anglo-Dutch Basin	4036
Anglo-Paris Basin	4040
Apulia Platform	4059
Aquitaine Basin	4045
Araks	2080
Armoricia	4041
Baltic Depression	4021
Baltic Shield-Norwegian Caledonides	4016
Barents Continental Slope	4013
Betic Zone	4078
Bohemia	4046
Bresse Depression	4054
Carpathian-Balkanian Basin	4061
Corsican-Sardinian Basins	4067
Crete	4076
Dinaric Alps	4071
Dobrogean Orogen	4063
Faeroes-Shetland-Orkney Basin	4019
Fennoscandian Border-Danish-Polish Margin	4022
Galician Basin	4073
German-Polish Basin	4033
Hammerfest-Varanger Basin	4015
Hatton-Rockall Basin	4020
Horda-Norwegian-Danish Basin	4023
Iberian Massif	4072
Iberic Cordillera	4083
Ireland-Scotland Platform	4026
Irish Sea	4030



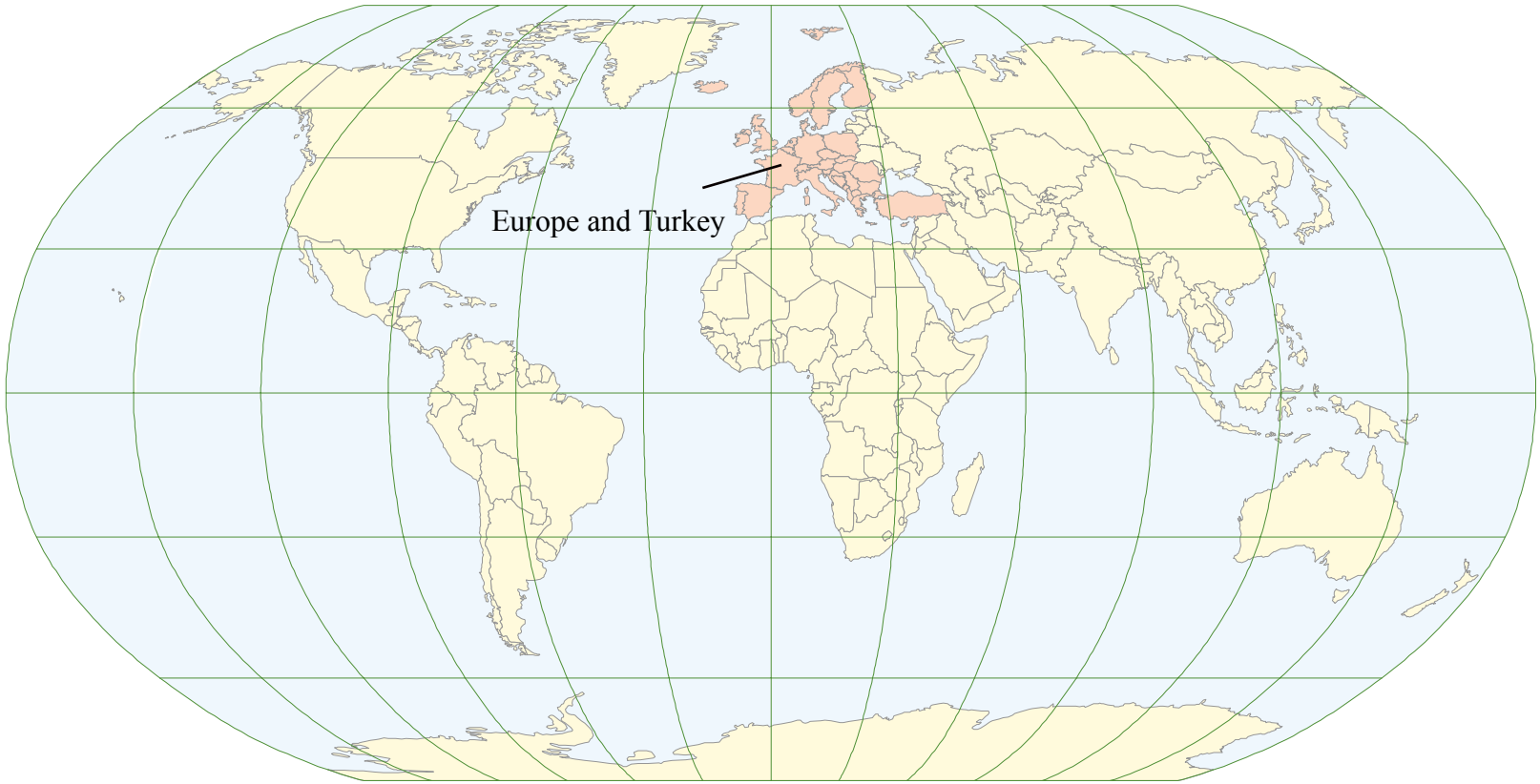
Jura	4052
Kardiff/Menders Massif	2084
Lesser Caucasus	2081
Lion-Camargue	4056
London-Brabant Platform	4037
Lusitanian Basin	4074
Massif Central	4043
Midland Valley-Forth Approaches Basin	4027
Mid-North Sea High	4028
Molasse Basin	4049
Munsterland Basin	4038
North Carpathian Basin	4047
North Sea Graben	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
Tyrrhenian 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



Projection: Robinson

EXPLANATION OF MAP UNITS AND SYMBOLS

SEDIMENTARY ROCK UNITS

- N — Neogene
- Pg — Paleogene
- K — Cretaceous
- J — Jurassic
- Tr — Triassic
- P — Permian
- C — Carboniferous
- D — Devonian
- S — Silurian
- O — Ordovician
- Є — Cambrian

- Q — Undivided Quaternary
- T — Undivided Tertiary
- TK — Tertiary-Cretaceous
- KJ — Cretaceous-Jurassic
- JTr — Jurassic-Triassic
- TrP — Triassic-Permian

- CD — Carboniferous-Devonian
- DS — Devonian-Silurian
- SO — Silurian-Ordovician
- OЄ — Ordovician-Cambrian

- Pzu — Upper Paleozoic
- Pzl — Lower Paleozoic

- Cz — Undivided Cenozoic
- Mz — Undivided Mesozoic
- Pz — Undivided Paleozoic
- pЄ — Undivided Precambrian

(Sedimentary and metamorphic Precambrian rocks are not differentiated)

- MzPz — Mesozoic-Paleozoic
- PzpЄ — Paleozoic-Precambrian

IGNEOUS AND METAMORPHIC ROCK UNITS

- Q — Quaternary volcanic rocks
- T — Tertiary volcanic rocks
- Undifferentiated volcanic rocks
- Undifferentiated intrusive rocks
- Amphibolites of undetermined age

- Cz — Cenozoic volcanic rocks
- CzMz — Cenozoic-Mesozoic intrusive rocks
- CzMz — Cenozoic-Mesozoic volcanic rocks
- Mz — Mesozoic volcanic rocks
- Mz — Mesozoic intrusive rocks
- Mz — Mesozoic metamorphic rocks
- MzPz — Mesozoic-Paleozoic metamorphic rocks
- Pz — Paleozoic volcanic rocks
- Pz — Paleozoic intrusive rocks
- Pz — Paleozoic metamorphic rocks
- PzpЄ — Paleozoic-Precambrian metamorphic rocks
- pЄ — Precambrian volcanic rocks
- pЄ — Precambrian intrusive rocks

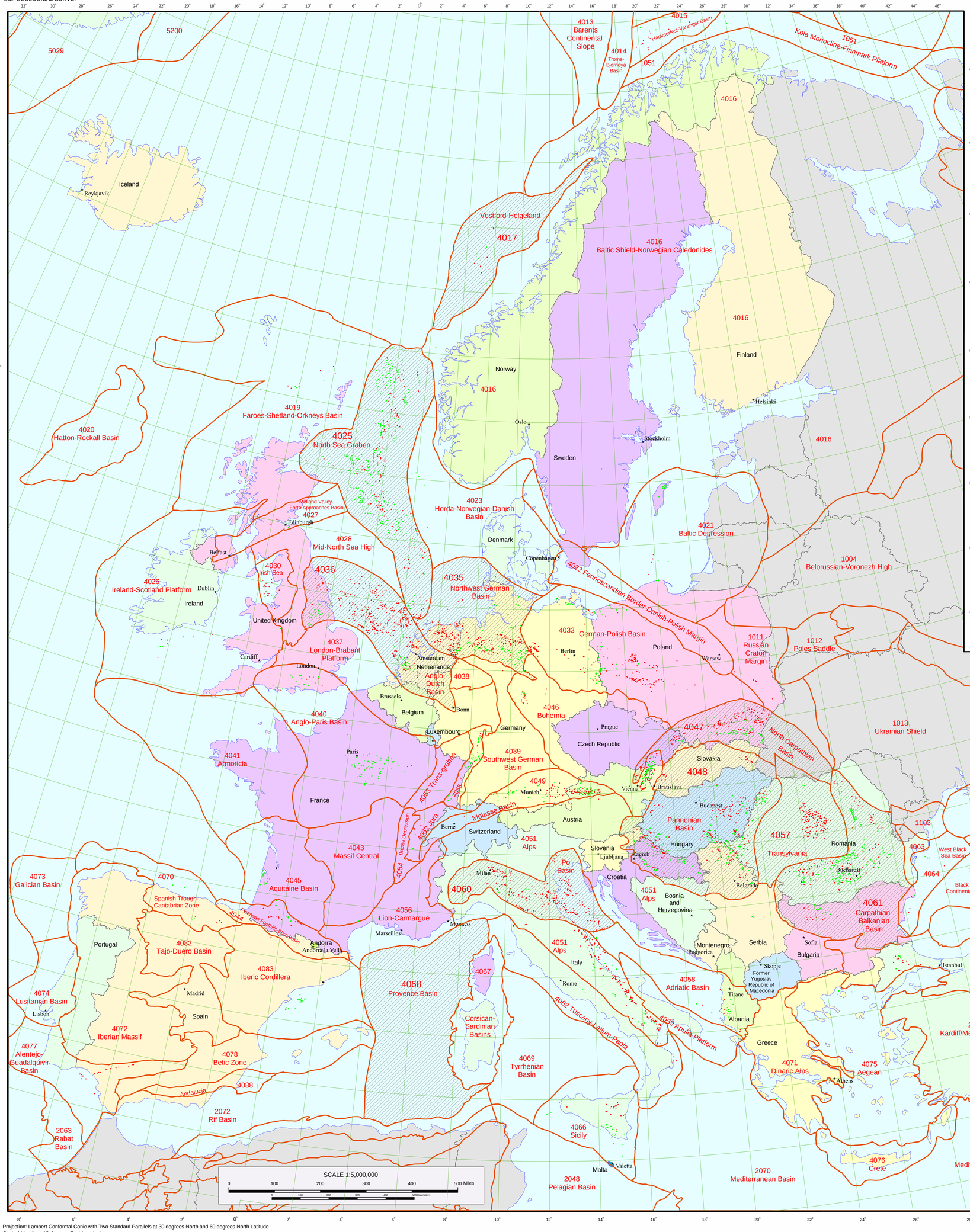
OTHER MAP UNITS

- 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

- Geologic province boundary
  province code indicated by red numeral
- Political boundary
- ★ Selected capital or major city
- Line of latitude or longitude,
  two degree interval

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

- Oil field center point
- Gas field centerpoint



EXPLANATION

- Oil field center point
- Gas field center point
- Geologic province boundary, province code indicated by red numeral
- Political boundary
- Selected capital or major city
- Line of latitude or longitude, two degree interval
- Geologic province assessed in U.S. Geological Survey World Assessment 2000

ABOUT THIS MAP

This 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 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 based on political boundaries and corresponding approximately to the economic regions of the world as defined by the U.S. Department of State. This map covers Europe including Turkey, and 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, Turkey, United Kingdom and Vatican City. (See index map below.)

The region is divided into geologic provinces (Klett and others, 1997). Each province has a set of geologic characteristics that distinguish it from surrounding provinces. These characteristics may include the dominant lithologies, the age of the strata, and the structural style. Offshore province boundaries are generally 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. The code numbers of those provinces that lie entirely within Europe begin with the number 4. The codes numbers of those provinces that lie within Turkey or the Eastern Mediterranean region begin with the number 2. The code numbers of those provinces that lie parly within another region may start with a 1, for the Former Soviet Union, or a 2 for the Middle East and North Africa. All the provinces are listed in Klett and others (1997). Iceland is not included in any geologic province defined by the U.S. Geological Survey.

Details of the data sources and map compilations are given in the metadata files on the CD-ROM and in the list of References. The center point locations of oil and gas fields are plotted based on the locations in the Petroconsultants database (1996) and are used with their pemission.

This map is compiled using Environmental Systems Research Institute, Inc. (ESRI) Arc/INFO software.

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.

Klett, T.J., Ahlbrandt, T.S., and Dolton, G.L., 1997, Ranking of the World's Oil and Gas Provinces by Known Petroleum Volumes, U.S. Geological Survey Open File Report 97-463, one CD-ROM.

Klett, T.J., Schmoker, J.W. and Ahlbrandt, T.S., 2000, Assessment hierarchy and initial provinces ranking: in U.S. Geological Survey World Energy Assessment Team, U.S. Geological Survey World Petroleum Assessment 2000 - Description and Results: U.S. Geological Survey Digital Data Series DDS 60, four CD-ROMs.

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

US. Geological Survey World Energy Assessment Team, 2000, U.S. Geological Survey World Petroleum Assessment 2000: U.S. Geological Survey Digital Data Series DDS60, four CD-ROMs, also available on the worldwide web at **http://greenwood.cr. usgs.gov/energy/WorldEnergy/DDS-60.**

Projection: Robinson

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

Projection: Lambert Conformal Conic with Two Standard Parallels at 30 degrees North and 60 degrees North Latitude
Central Meridian: 12 degrees East Longitude

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT 97-470I

EXPLANATION OF MAP UNITS AND SYMBOLS

SEDIMENTARY ROCK UNITS

- N Neogene
- Pg Paleogene
- K Cretaceous
- J Jurassic
- Tr Triassic
- P Permian
- C Carboniferous
- D Devonian
- S Silurian
- O Ordovician
- Ꞓ Cambrian
- Q Undivided Quaternary
- T Undivided Tertiary
- TK Tertiary-Cretaceous
- KJ Cretaceous-Jurassic
- JTr Jurassic-Triassic
- TrP Triassic-Permian
- CD Carboniferous-Devonian
- DS Devonian-Silurian
- SO Silurian-Ordovician
- OC Ordovician-Cambrian
- Cz Undivided Cenozoic
- Mz Undivided Mesozoic
- Pz Undivided Paleozoic
- pC Undivided Precambrian
  (Sedimentary and metamorphic Precambrian rocks are not differentiated)
- PzU Upper Paleozoic
- PzL Lower Paleozoic
- MzPz Mesozoic-Paleozoic
- PzpC Paleozoic-Precambrian

IGNEOUS AND METAMORPHIC ROCK UNITS

- Undifferentiated volcanic rocks
- Undifferentiated intrusive rocks
- Amphibolites of undetermined age
- Cz Cenozoic volcanic rocks
- CzMz Cenozoic-Mesozoic intrusive rocks
- CzMz Cenozoic-Mesozoic volcanic rocks
- Mz Mesozoic volcanic rocks
- Mz Mesozoic intrusive rocks
- Mz Mesozoic metamorphic rocks
- MzPz Mesozoic-Paleozoic metamorphic rocks
- Pz Paleozoic volcanic rocks
- Pz Paleozoic intrusive rocks
- Pz Paleozoic metamorphic rocks
- pC Precambrian volcanic rocks
- pC Precambrian intrusive rocks
- PzpC Paleozoic-Precambrian metamorphic rocks

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
- Fault
- Inferred fault
- Thrust fault
- Inferred thrust fault
- 200 Bathymetric depth contour, depth in meters as blue numeral
- Geologic province boundary, province code as red numeral
- Political boundary
- Selected capital or major city
- Line of latitude or longitude, two degree interval

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.

Gaertner, H.-R. v., Walther, H.W., Weber, H.S., and Voss, H.-H., 1971, The International Geological Map of Europe and the Mediterranean Region; United Nations Educational, Scientific and Cultural Organization (UNESCO) and the Commission for the Geological Map of the World (CMGW), 2 sheets, scale 1:5,000,000.

Klett, T.J., Ahlbrandt, T.S., and Dolton, D.L., 1997, Ranking of the World's Oil and Gas Provinces by Known Petroleum Values, U.S. Geological Survey Open File Report 97-463, one CD-ROM.

Klett, T.J., Schmoker, J.W., and Ahlbrandt, T.S., 2000, Assessment hierarchy and initial province ranking: *in* U.S. Geological Survey World Energy Assessment Team, U.S. Geological Survey World Petroleum Assessment 2000 – Description and Results: U.S. Geological Survey Digital Data Series DDS 60, 4 CD-ROMs.

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

U.S. Geological Survey World Energy Assessment Team, 2000, U.S. Geological Survey World Petroleum Assessment 2000: U.S. Geological Survey Digital Data Series DDS 60, 4 CD-ROMs, also available on the world wide web at **http://greenwood.cr.usgs.gov/energy/WorldEnergy/DDS-60**.

SCALE 1:5,000,000

0 100 200 300 400 500 Miles
0 100 200 300 400 500 Kilometers

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

Projection: Lambert Conformal Conic with Two Standard Parallels at 30 degrees North and 60 degrees North Latitude
Central Meridian: 12 degrees East Longitude

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

Digitally compiled by Mark J. Pawlewicz, Douglas W. Steinshouer and Donald L. Gautier

2002

INTERIOR - GEOLOGICAL SURVEY - DENVER, CO - 2002

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 (BCFG).