

High enthalpy geothermal resources of Greece for power generation & district heating

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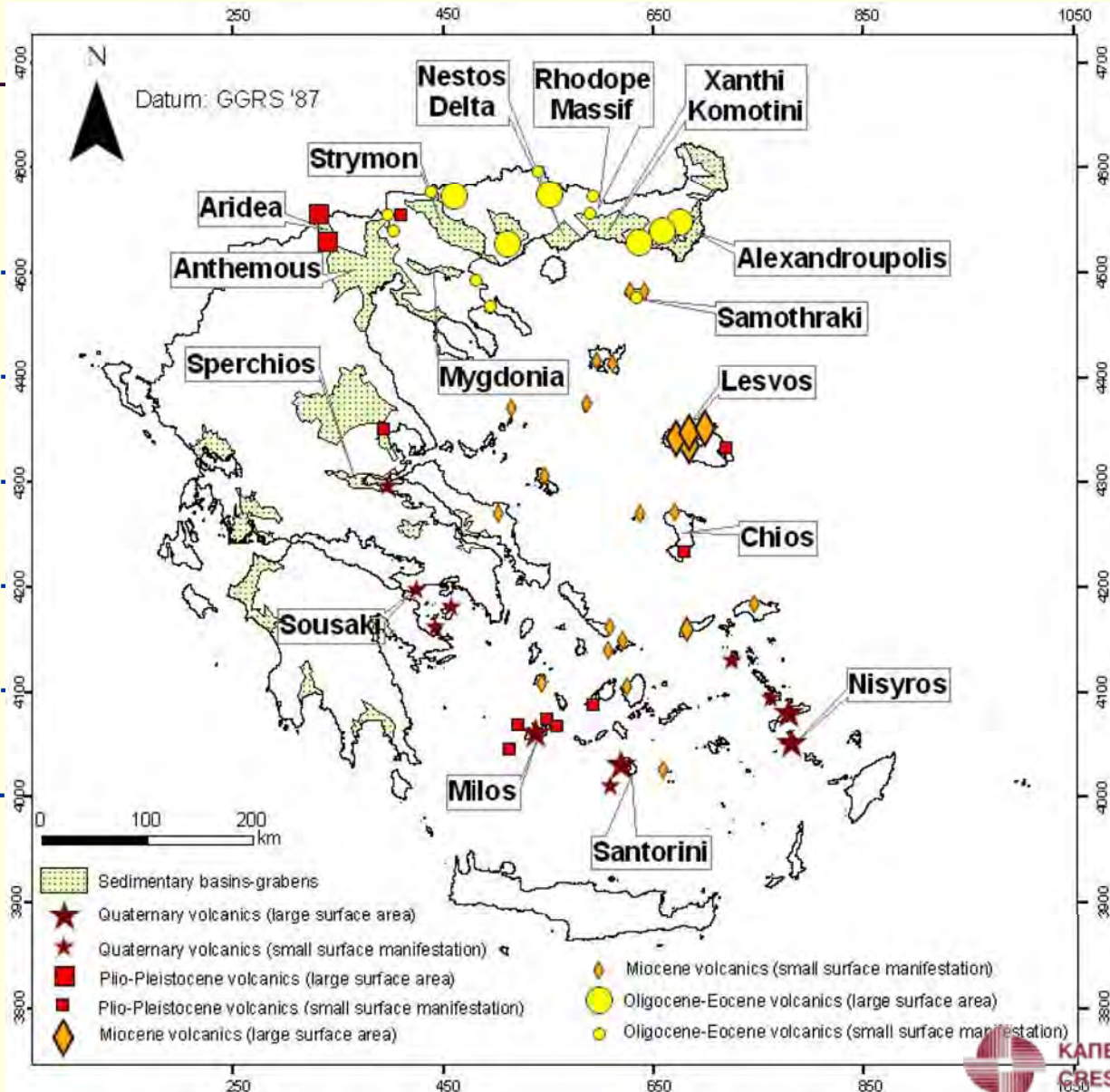
Geothermal fields & volcanic activity in neighboring countries

	Geothermal fluid temperature	Age of volcanic rocks
Italy, Tuscany	350 °C	Pliocene <i>(1.8 – 5.3 million years)</i>
Turkey	170 °C	Oligocene <i>(23.8 – 33.7 million years)</i>

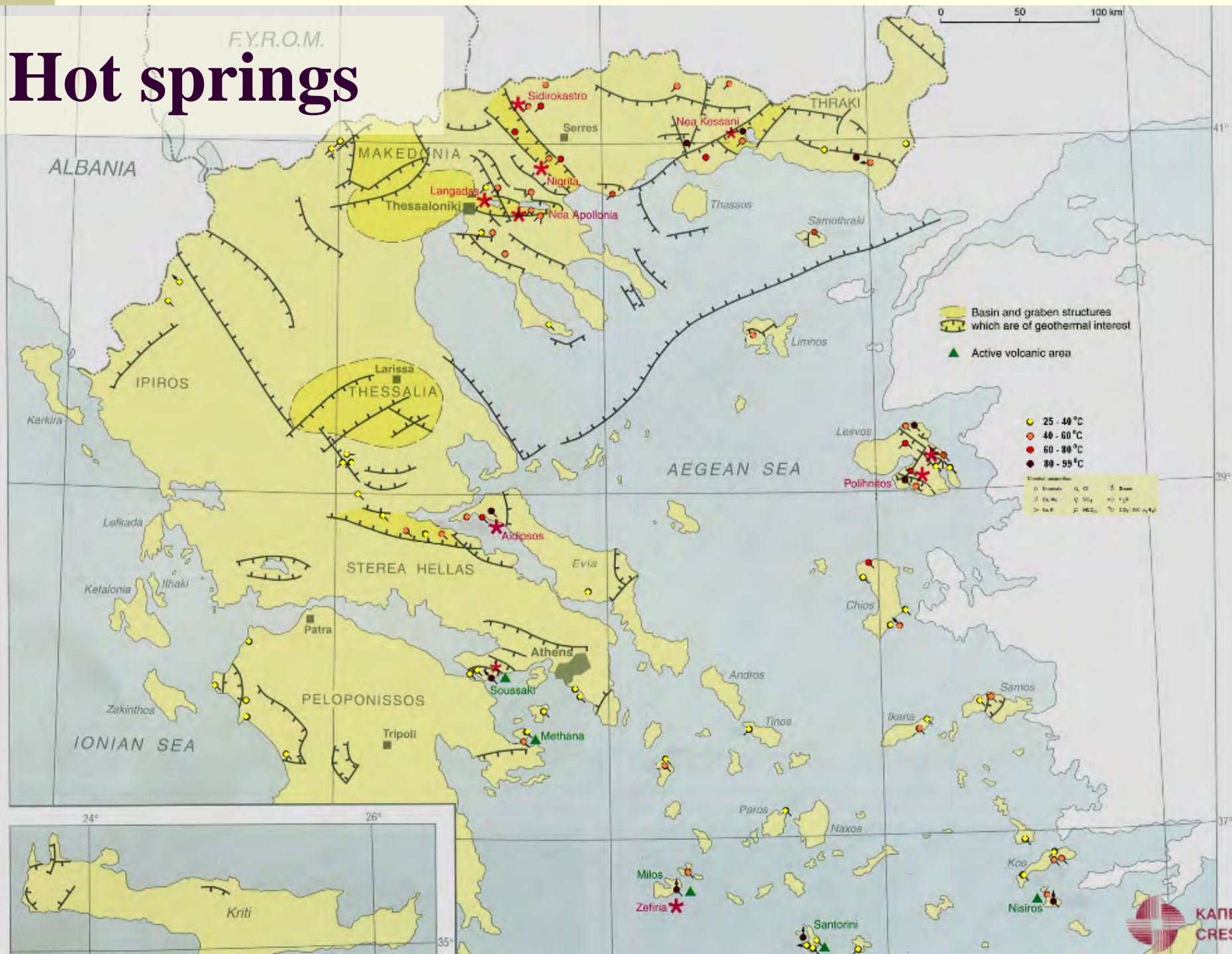
Volcanic rocks in Greece

Years

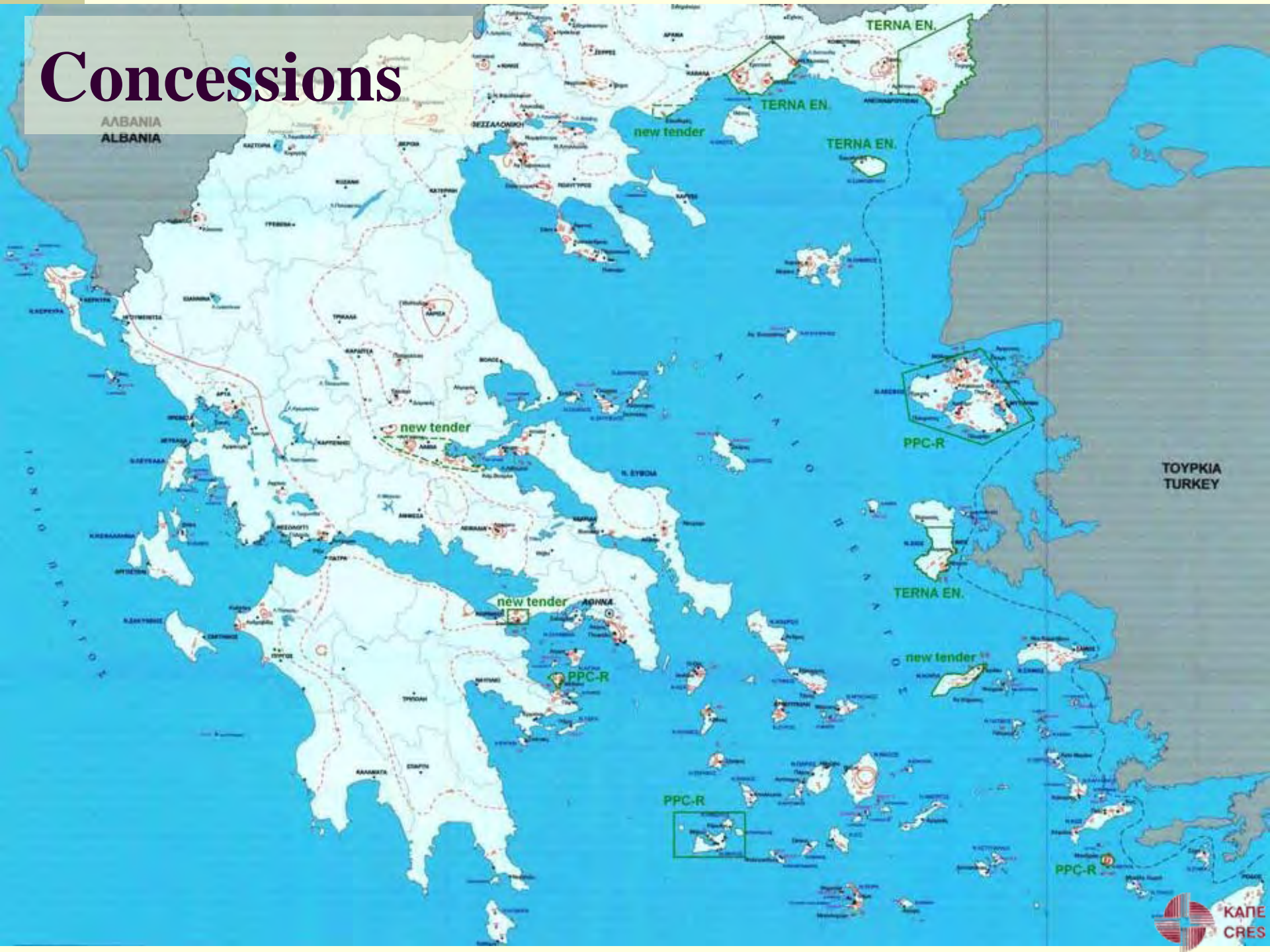
- 0 ----- Quaternary
- 1.8 M ----- Pliocene
- 5.3 M ----- Miocene
- 23.8 M ----- Oligocene
- 33.7 M ----- Eocene
- 54.8 M -----



Hot springs



Concessions



TOYPKIA
TURKEY

Milos island

local electricity demand
 PPC: 7 MWe
 S & B: 7 MWe

five deep wells
 depth: 1 – 1.4 km
 T = 300-320 °C

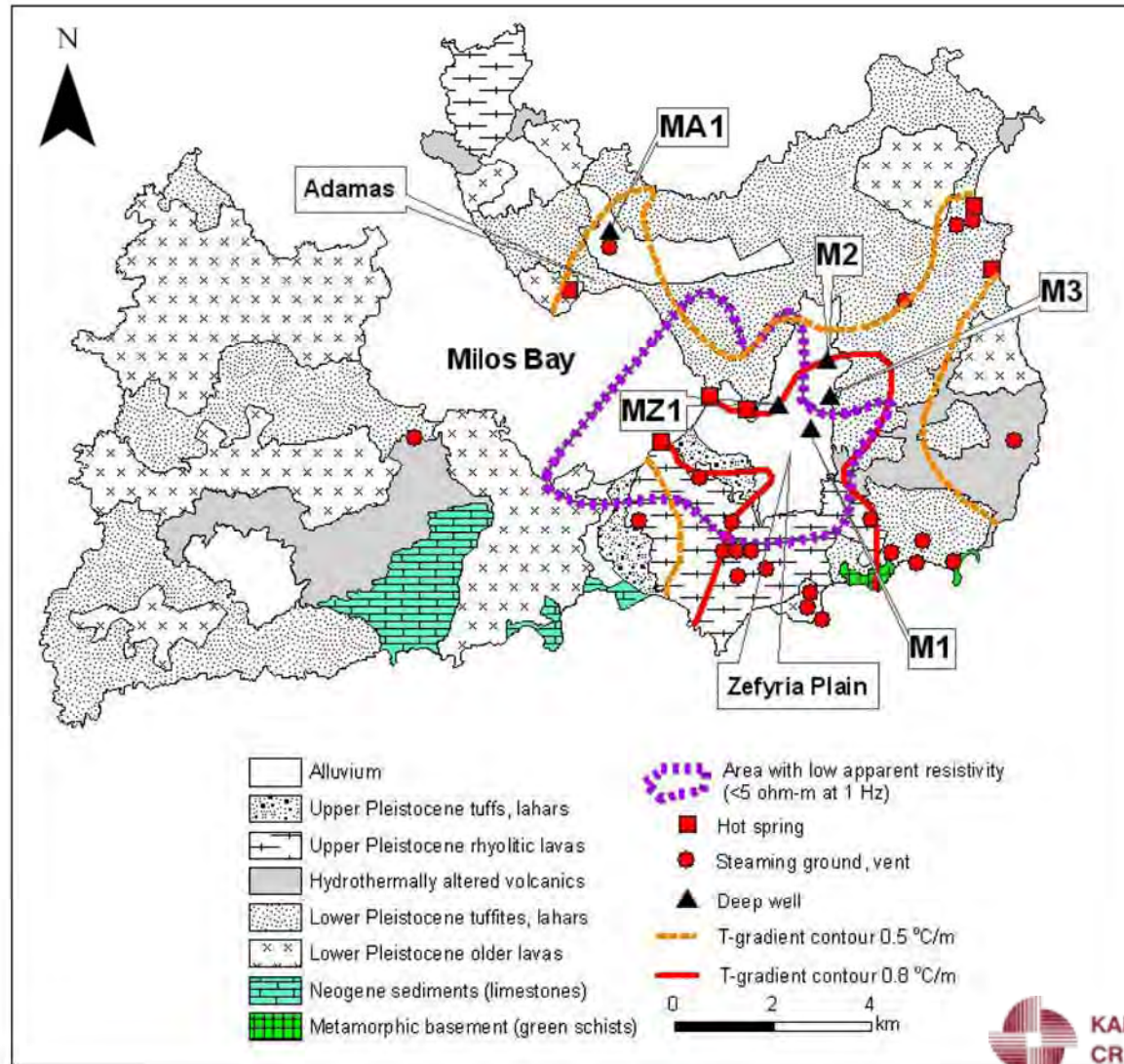
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Geophysical exploration



Geothermal reserves

150 MWe
 Justified for development



Nisyros island

two deep wells
depth: 1.5 – 2 km
T = 250-350 °C

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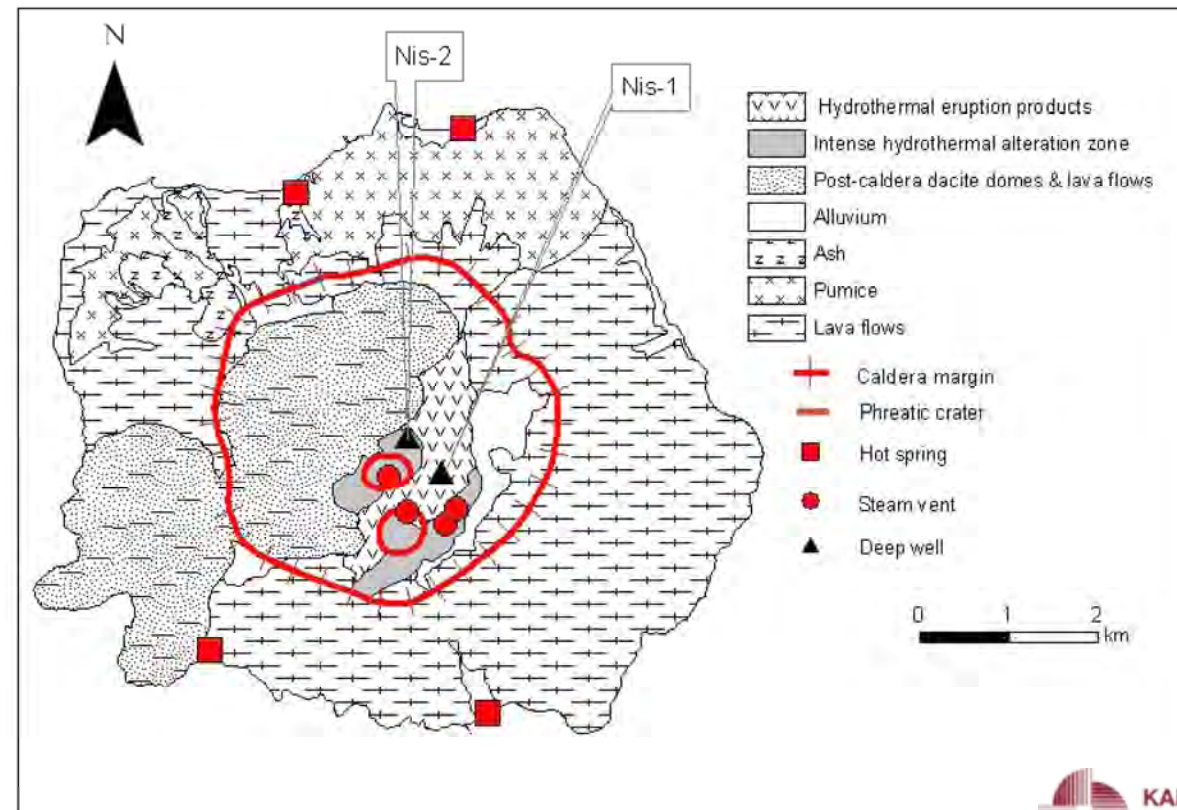
Geophysical exploration



Geothermal reserves

50 MWe
Justified for development

local electricity demand
Nisyros: 5 MWe
Kos: 60 MWe



Lesvos island

wells

depth: 0.2-1.4 km

T = 80-104 °C

&

geothermometer

K/Mg/Na

Argenos \Rightarrow 127/217 °C

Thermie \Rightarrow 110/175 °C

MI=2.03-2.14

&

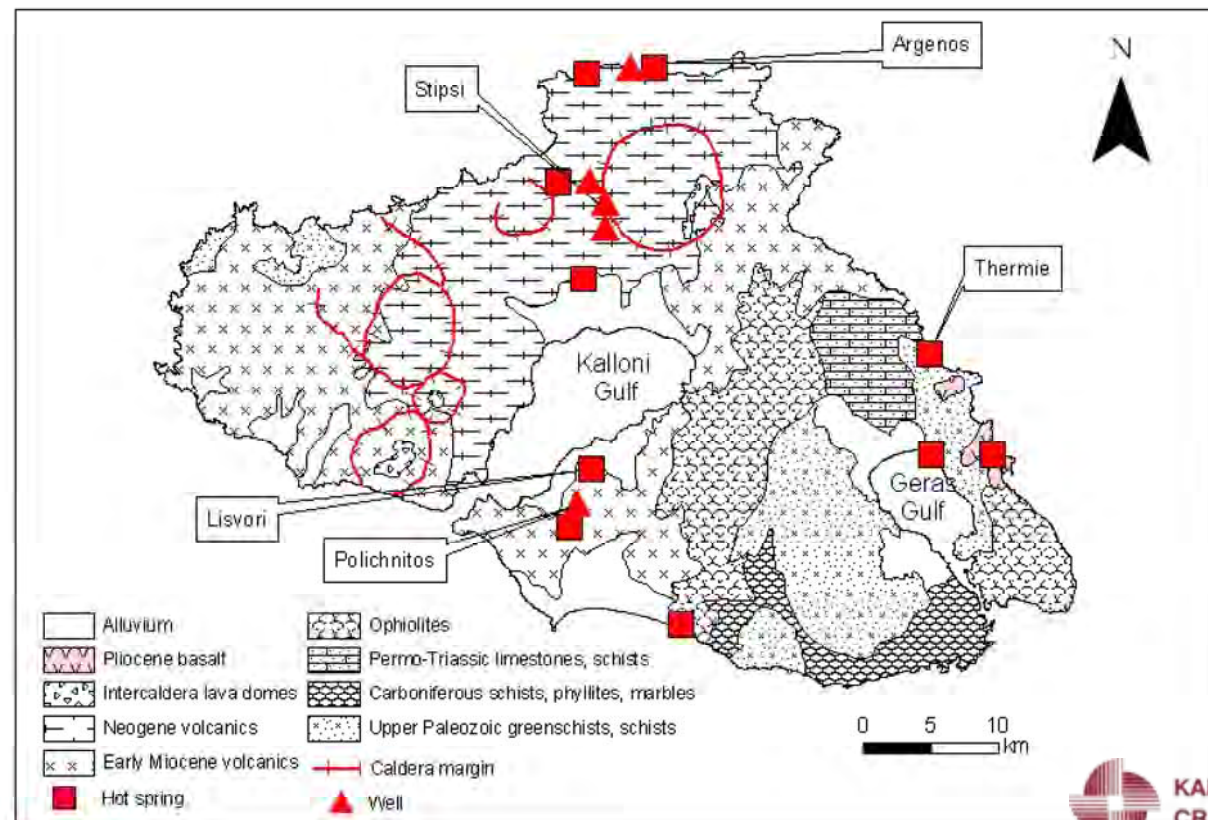
3D-MT survey



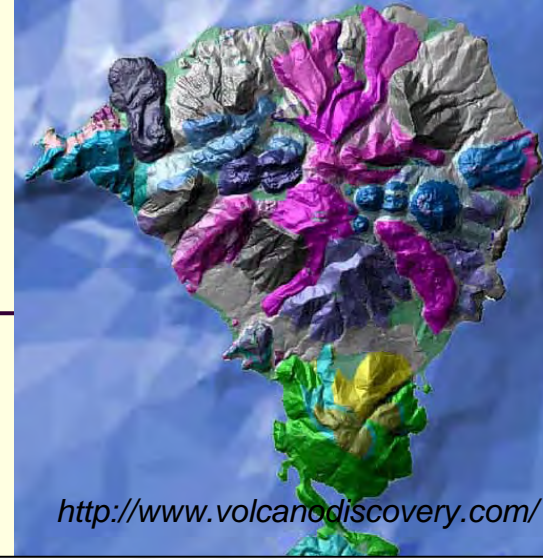
Geothermal prospect

local electricity demand

50 MWe



Methana Peninsula



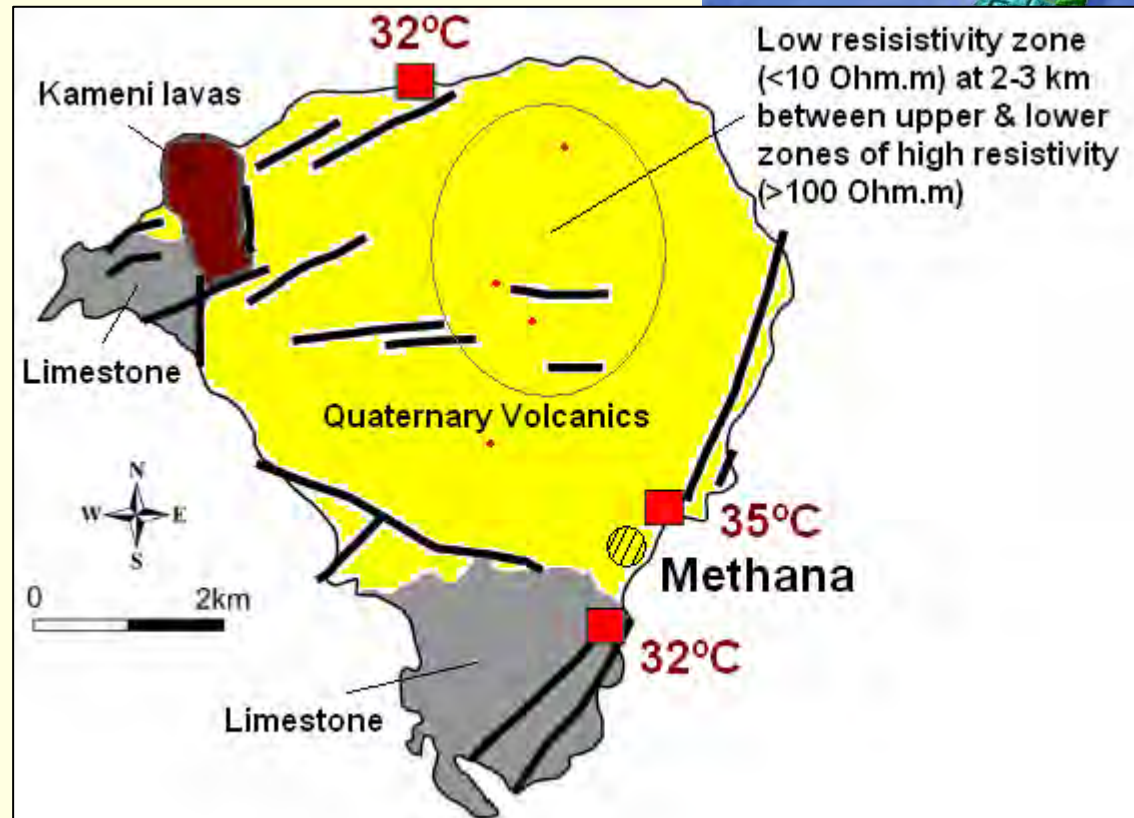
Active volcano
Springs
32-35 °C
geothermometer
K/Mg/Na \Rightarrow 110/190 °C
MI=2.07

&

2D-MT survey



Geothermal lead



Santorini island

wells
depth: <0.5 km
T = 65 °C

local electricity demand
25 MWe

&

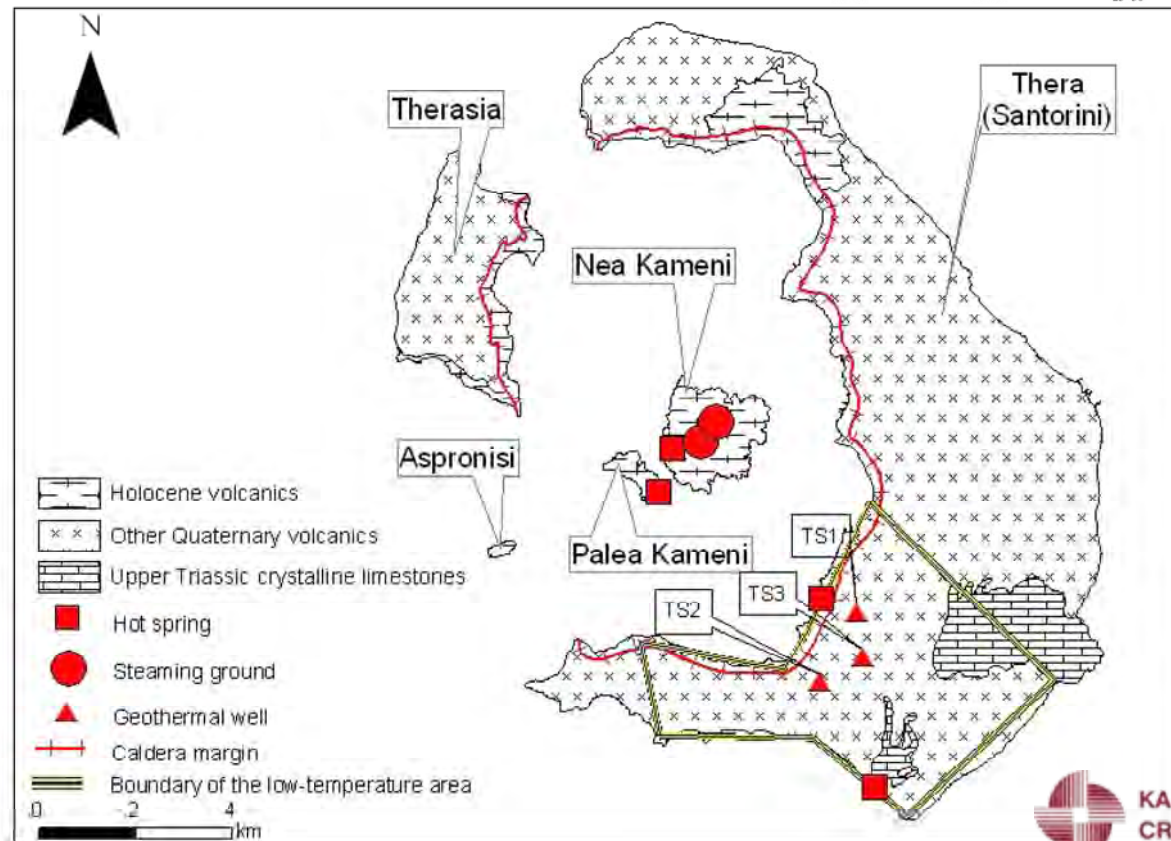
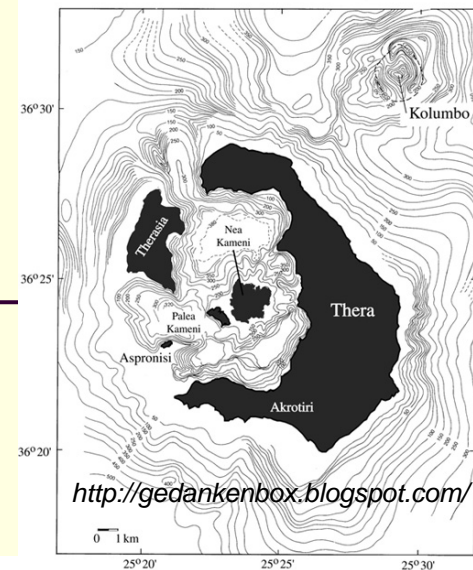
Active volcano
Fumaroles
⇒ >100 °C
geothermometer
K/Mg/Na ⇒ 110/174 °C
MI=2.14

&

Gravity mapping

⇓

Geothermal lead



Kos island

Quaternary volcanic products from two submarine volcanoes

Hot spring

45 °C

geothermometer

K/Mg/Na \Rightarrow 110/190 °C

MI=2.07

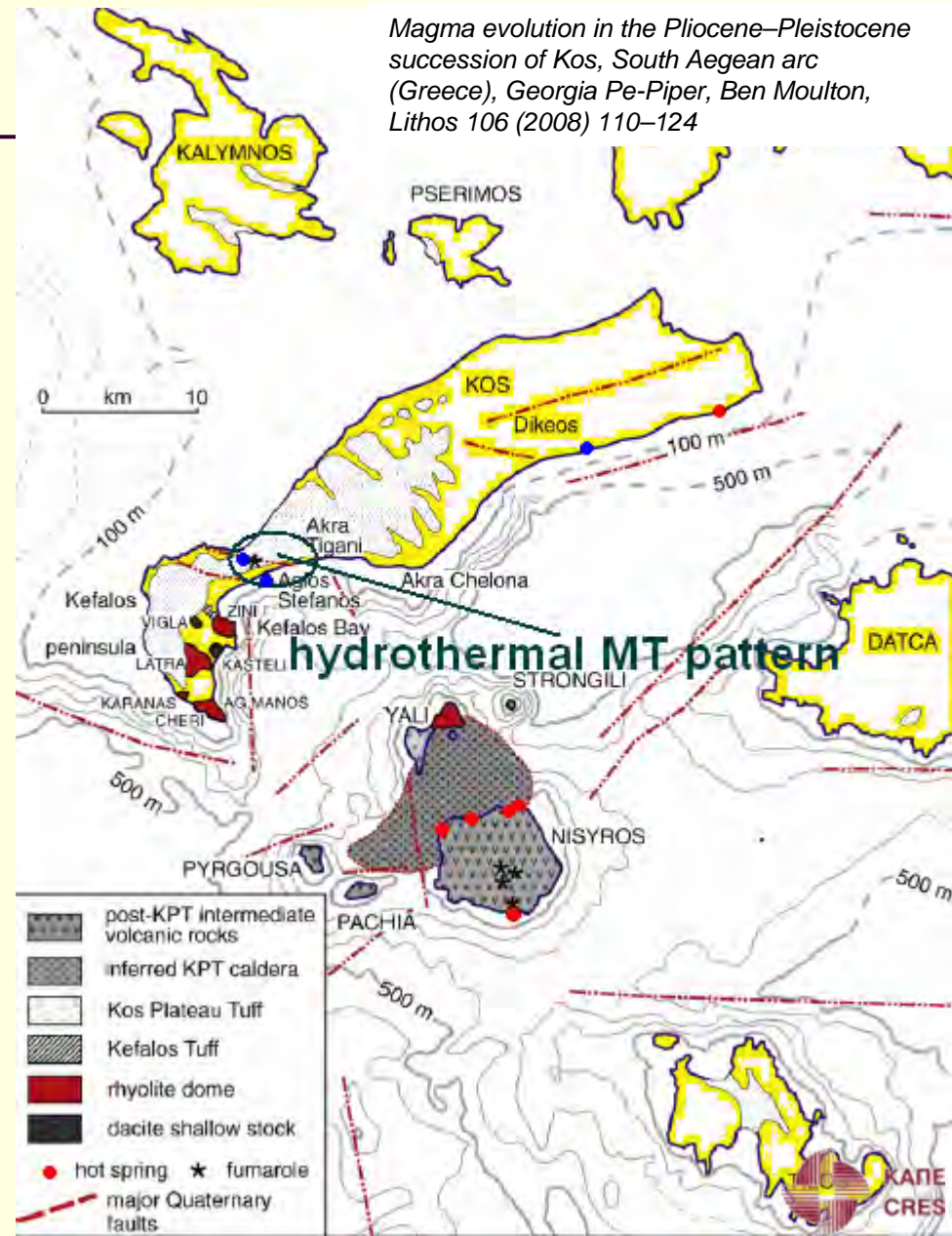
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2D-MT survey

local electricity demand

60 MWe

Magma evolution in the Pliocene–Pleistocene succession of Kos, South Aegean arc (Greece), Georgia Pe-Piper, Ben Moulton, Lithos 106 (2008) 110–124



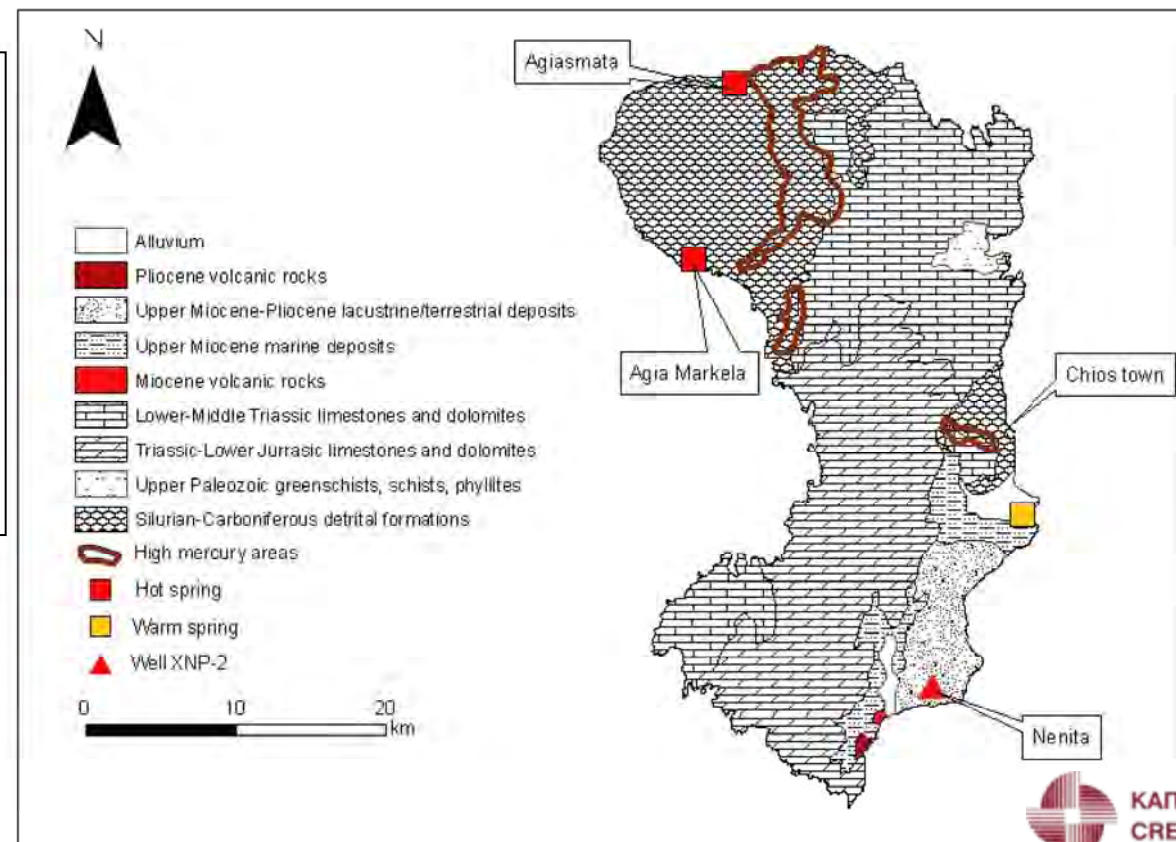
Chios island

wells
depth: <0.5 km
T = 80 °C

local electricity demand
40 MWe

geothermometer
K/Mg/Na

Agiasmata \Rightarrow 150/245 °C
Ag.Markela \Rightarrow 140/215 °C
Nenita \Rightarrow 150/210 °C
MI=2.06-2.27



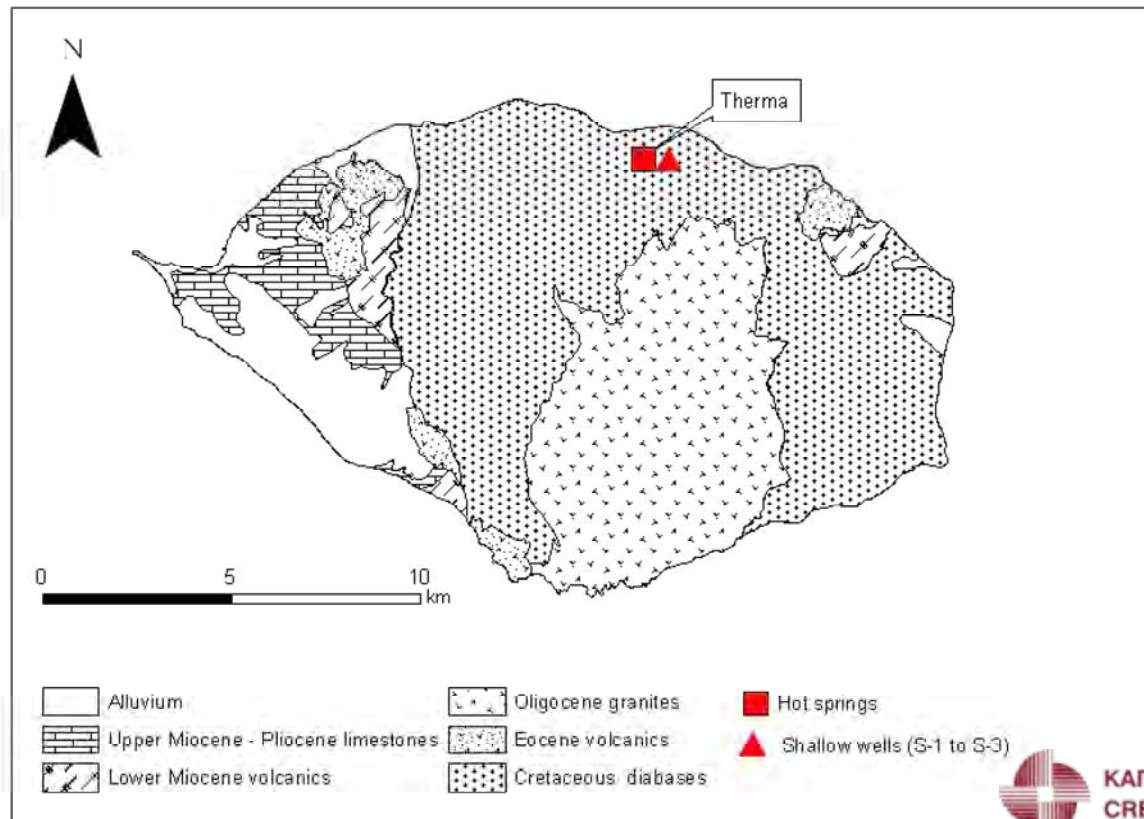
Samothraki island

wells
depth: <0.1 km
T = 100 °C

local electricity demand
5 MWe

geothermometer
K/Mg/Na

Therma \Rightarrow 170/250 °C
MI=2.21



Ikaria island

Miocene to Pliocene
granodiorite

springs

$T = 43\text{-}59\text{ }^{\circ}\text{C}$

Heat flow $>5\text{ MW}_{\text{th}}$

local electricity demand

Ikaria : 10 MWe

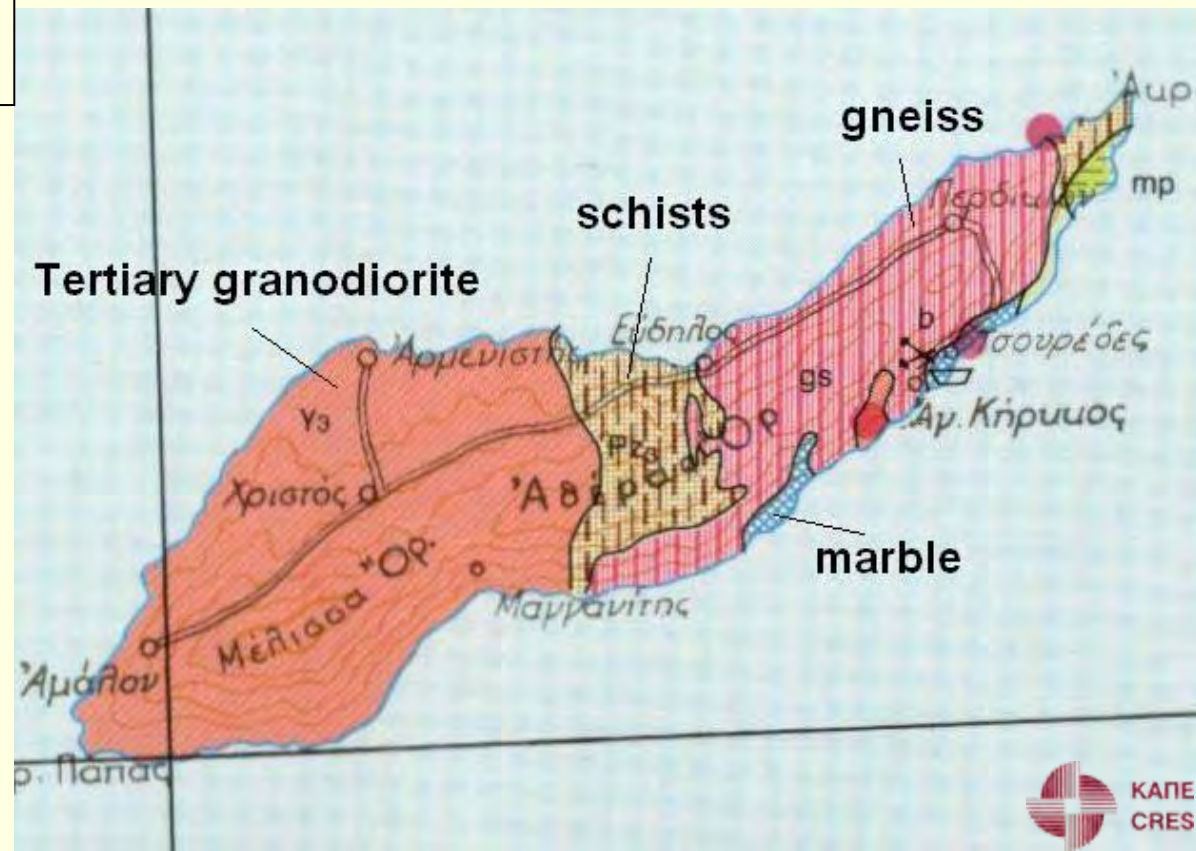
Samos: 65 MWe

geothermometer

K/Mg/Na

Therma $\Rightarrow 110/180\text{ }^{\circ}\text{C}$

MI=2.13



South Evros

thermal wells

Βάθος: <0.5 km
T = 50-85 °C

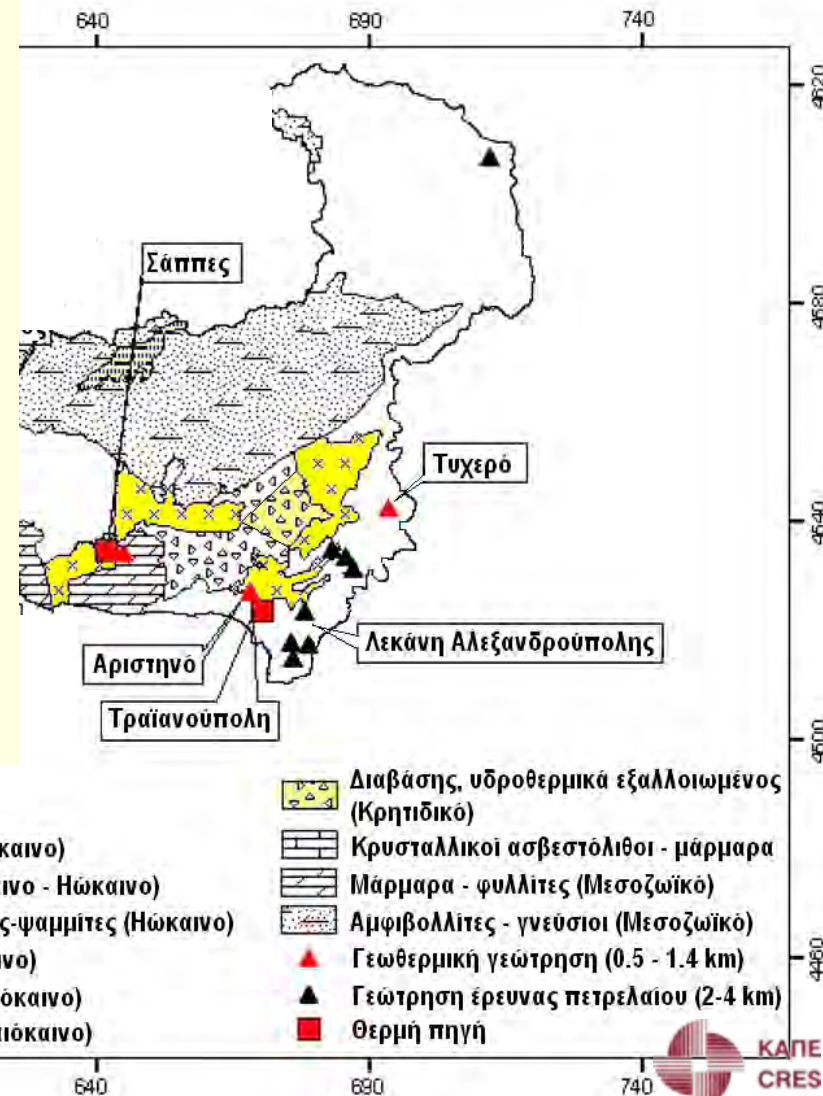
geothermometer

K/Mg/Na

Aristino ⇒ 125/180 °C MI=2.44
Trainoupolis ⇒ 135/190 °C MI=2.26
Tycherο ⇒ 60/135 °C MI<2
Sappes ⇒ 115/235 °C MI<2

deep wells

Evros basin
depth: 3-4 km
T = 100-140 °C

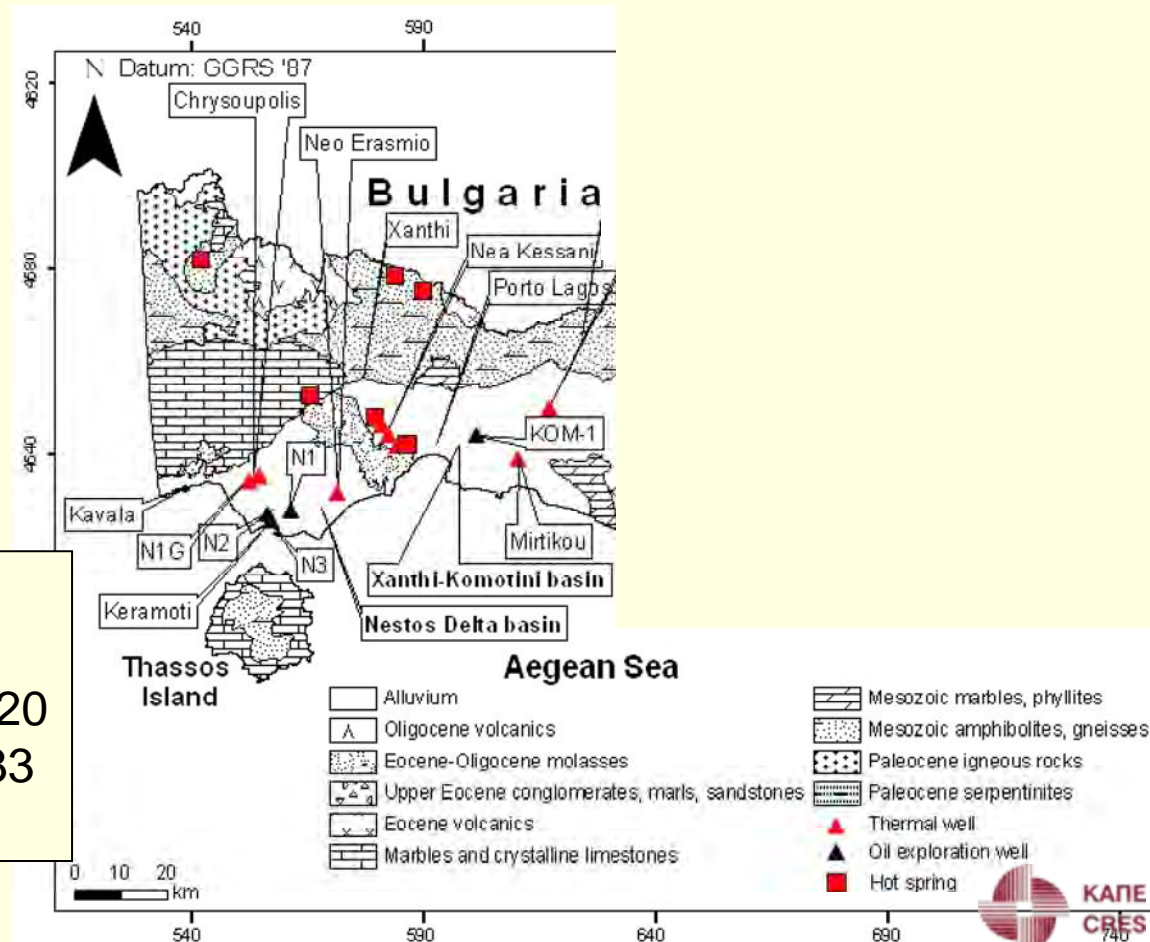


Delta Nestos – Porto Lagos

thermal wells
depth: <1 km
T = 60-80 °C

deep wells
Keramoti
depth: 3-4 km
T = 120-165 °C
well N1G
depth: 1.4 km
T = 120 °C

geothermometer
K/Mg/Na
Chrysoupolis ⇒ 80/125 °C MI=2.20
N.Erasmio ⇒ 160/210 °C MI=2.33
N.Kessani ⇒ 130/240 °C MI<2



Strymon basin - Mygdonia graben

thermal wells

depth: <0.5 km

Agistro: 50 °C

Sidirokastro: 75 °C

Iraklia: 60 °C

Nigrita: 65 °C

Achinos-Ivira: 35 °C

Akropotamos: 90 °C

Nea Apolonia: 55 °C

Langadas: 40 °C

geothermometer

K/Mg/Na

Agistro ⇒ 55/175 °C MI<2

Sidirokastro ⇒ 100/300 °C MI<2

Iraklia ⇒ 80/190 °C MI<2

Nigrita ⇒ 90/280 °C MI<2

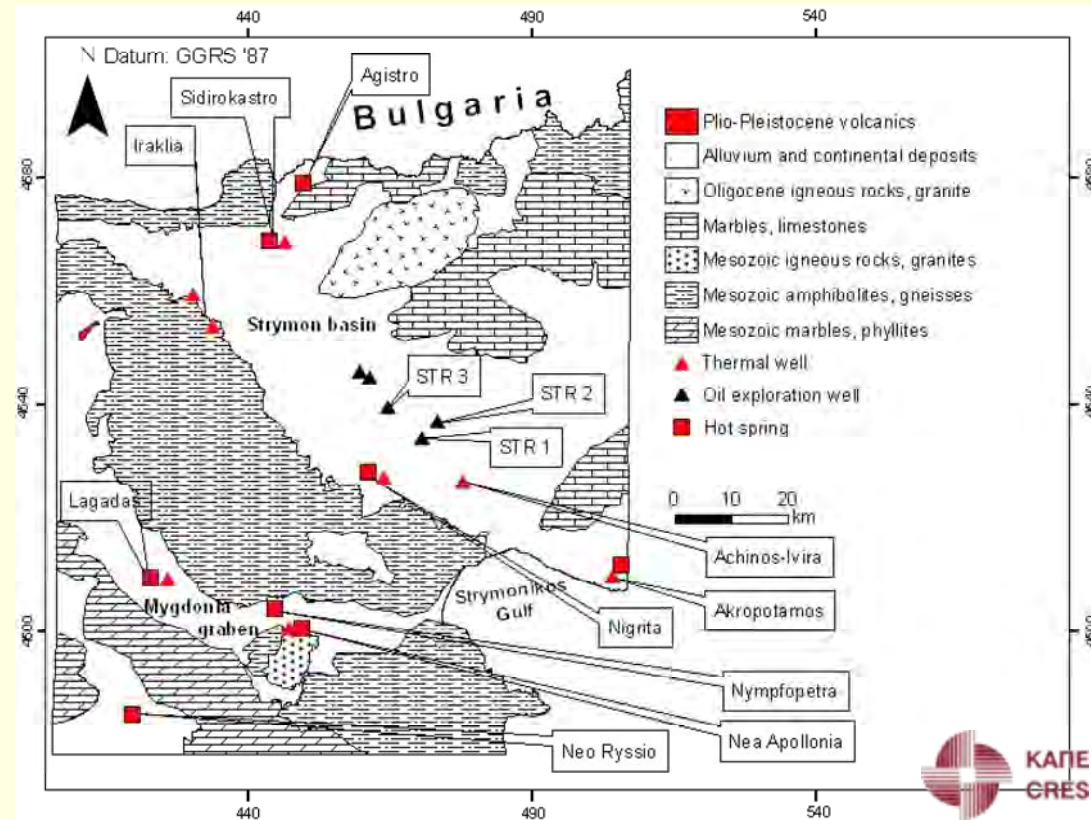
Akropotamos ⇒ 110/250 °C MI<2

Nea Apolonia ⇒ 80/155 °C MI<2

deep wells

depth: 2.7-3.7 km

T = 90-135 °C



Sperchios-N.Evoikos graben

Aidipsos: 81 °C

Gialtra: 50 °C

Kamena Vourla: 46 °C

Thermopylae: 44 °C

Loutra Ypatis: 32 °C

Loutra Platystomou: 34 °C

geothermometer

K/Mg/Na

Aidipsos \Rightarrow 120/175 °C MI=2.25

Thermopylae \Rightarrow 105/180 °C MI=2.04

Kamena Vourla \Rightarrow 100/190 °C M<2

Loutra Ypatis \Rightarrow 95/230 °C M<2

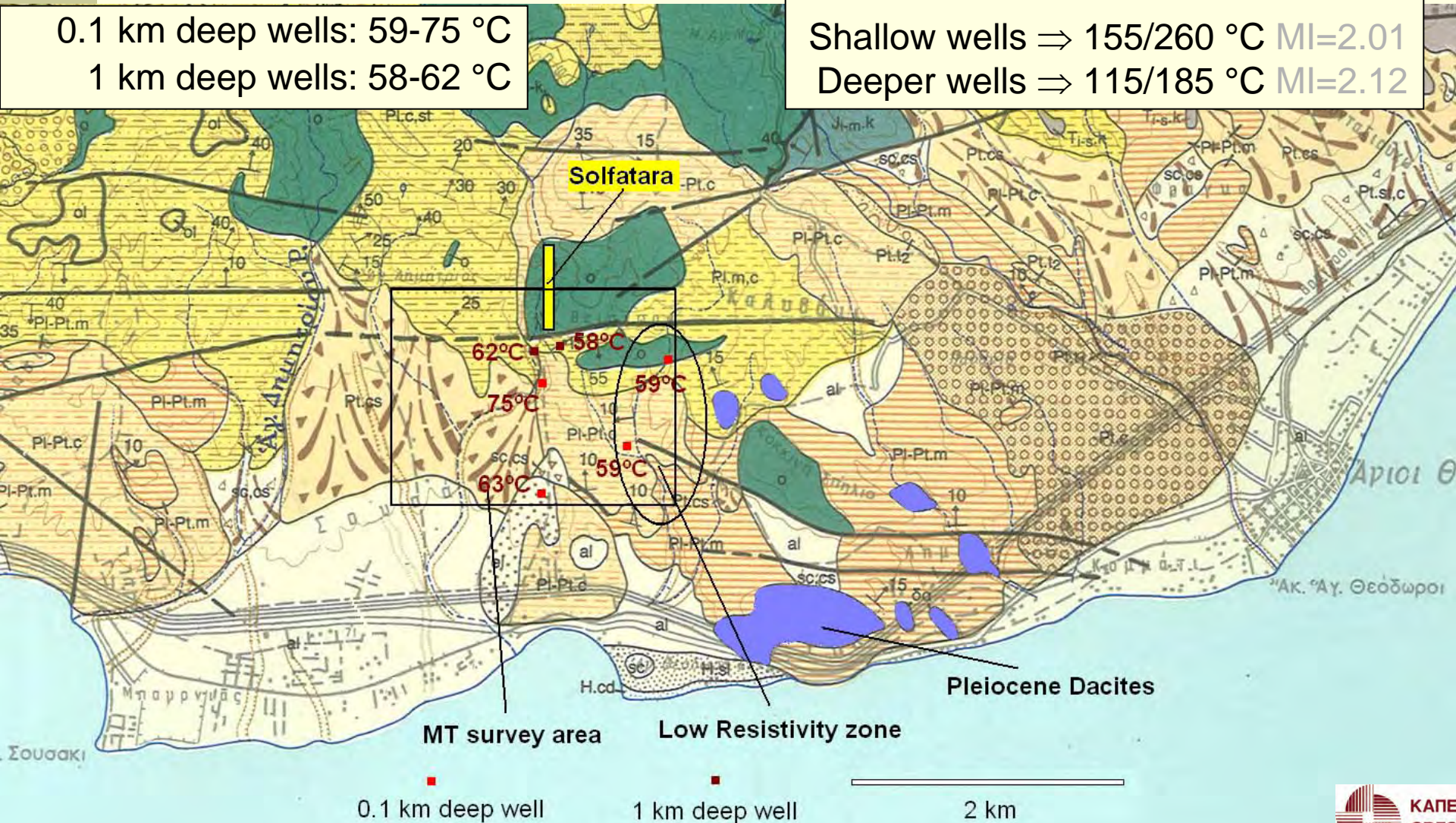


Sousaki

geothermometer
K/Mg/Na

0.1 km deep wells: 59-75 °C
1 km deep wells: 58-62 °C

Shallow wells \Rightarrow 155/260 °C MI=2.01
Deeper wells \Rightarrow 115/185 °C MI=2.12



Development prospects

Milos & Nisyros

- Field development & power plant construction can start immediately
- Local power needs can be covered in 3 years time
- Exploitation at full potential possible only after connecting the islands to main grid

Elsewhere

- Geophysical & geochemical exploration necessary
- Followed by drilling exploration with 3 km deep wells
- First power plants after 5-7 years



Thank you for your attention