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Hydrochemistry, isotopic ratios and origin of thermal fluids in eastern Anatolia, Turkey

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TÜBİTAK-ÇAYDAG
Project No: 114Y067

TÜBİTAK

September 28, 2016
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N°abstract **1992**

25-29th September 2016
Montpellier, France
CORUM CONFERENCE CENTER
43rd IAH congress

Outline

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- **Geologic Setting**
- **Scope**
- **Sampling Points & Analysis**
  - Springs
- **Results**
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  - Environmental Isotope Compositions
  - $\delta^{13}C(DIC)$, $\delta^{34}S(SO_4)$ & $\delta^{18}O$ (SO_4) Compositions
  - He – C Compositions
  - Results
- **Conclusions**

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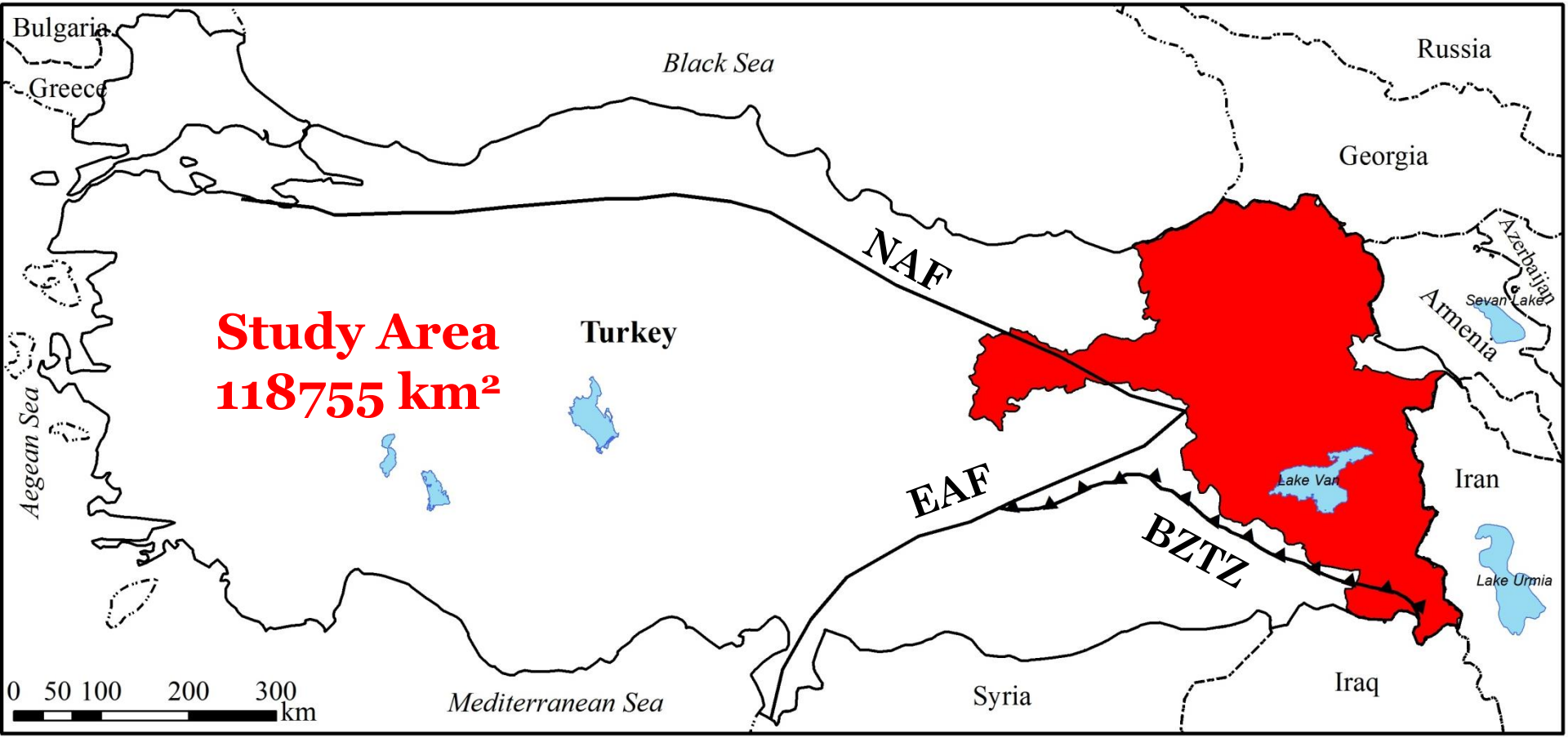
Study Area



Main Tectonic Zones

North Anatolian Fault (NAF)
East Anatolian Fault (EAF)
Bitlis-Zagros Thrust Zone (BZTZ)

Geologic Setting

Description

- Cities
- Normal Fault
- Thrust Fault
- Study Area
- Lakes and Dams

Tectonic Units

- AP — Arabian Plate
- BPM — Bitlis-Poturge Massif
- EAAC — East Anatolian Accretionary Complex
- NIF — Northwest Iranian Fragment
- RPF — Rhodope-Pontide Fragmente

(Şengör et al., 2003; Keskin, 2007)

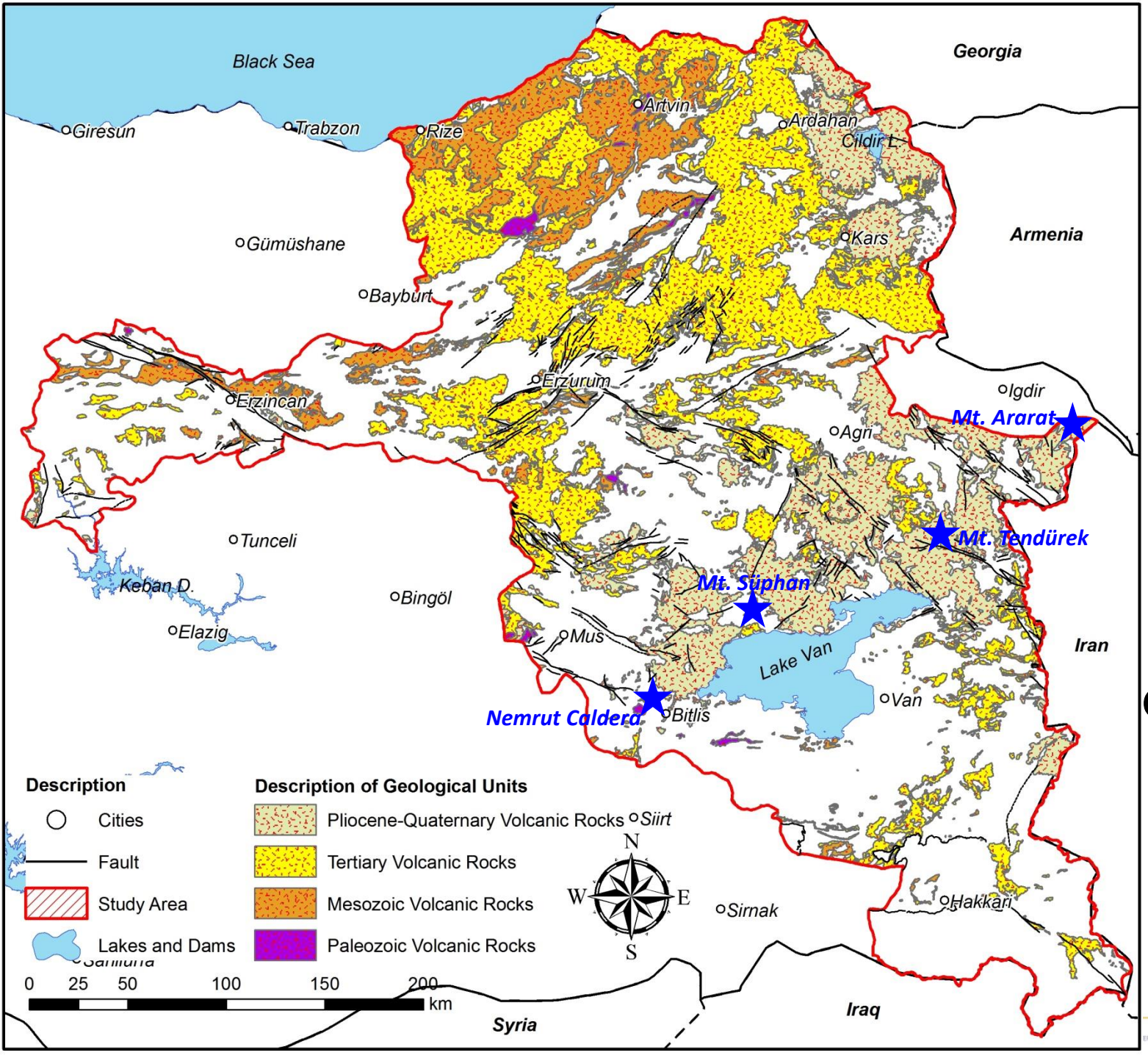
N W E S

0 25 50 100 150 200 km

Neotectonic Era

Middle Miocene

Paleotectonic Era

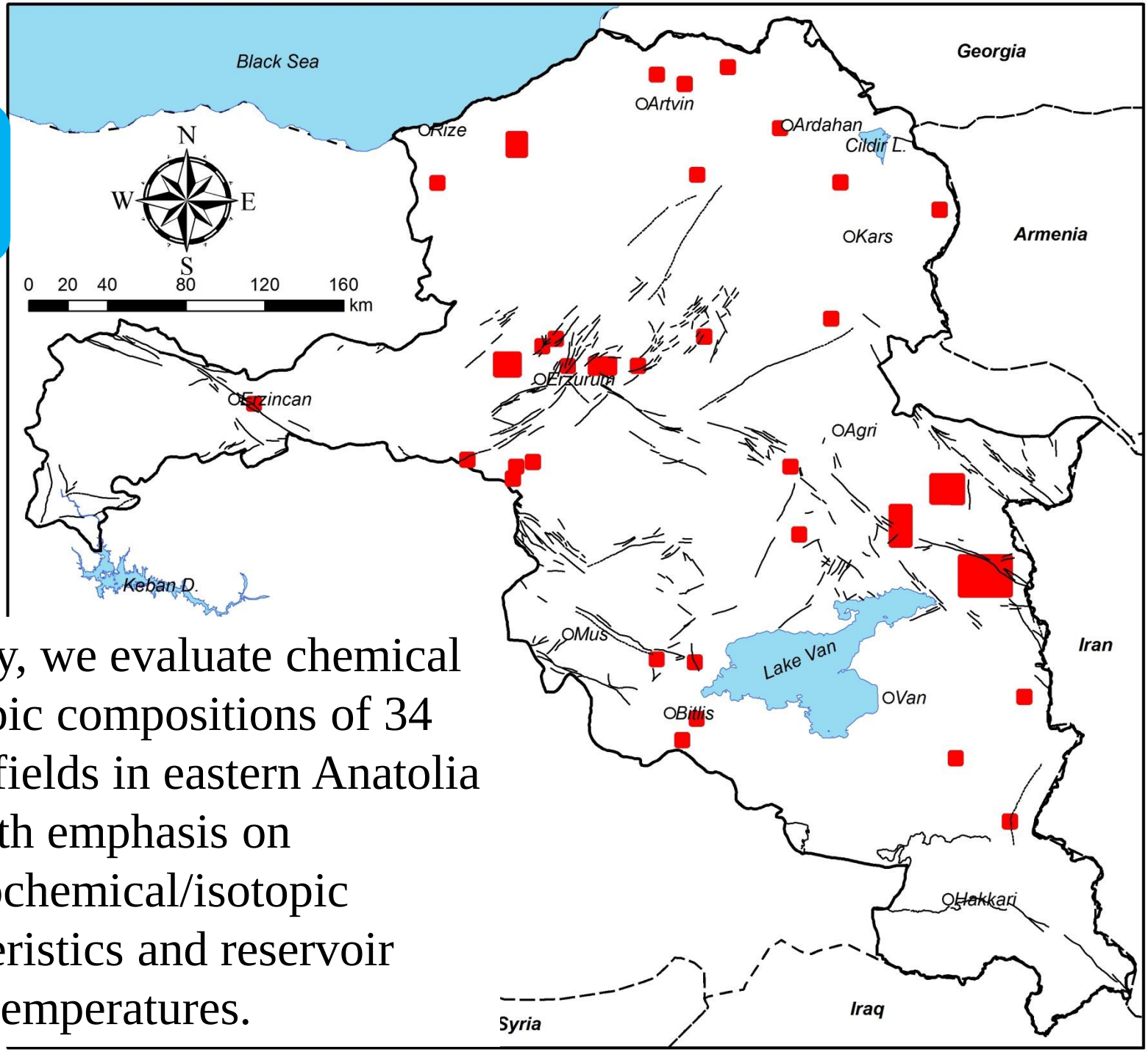


Anatolia, Neogene volcanism and tectonism

High Geothermal Potential

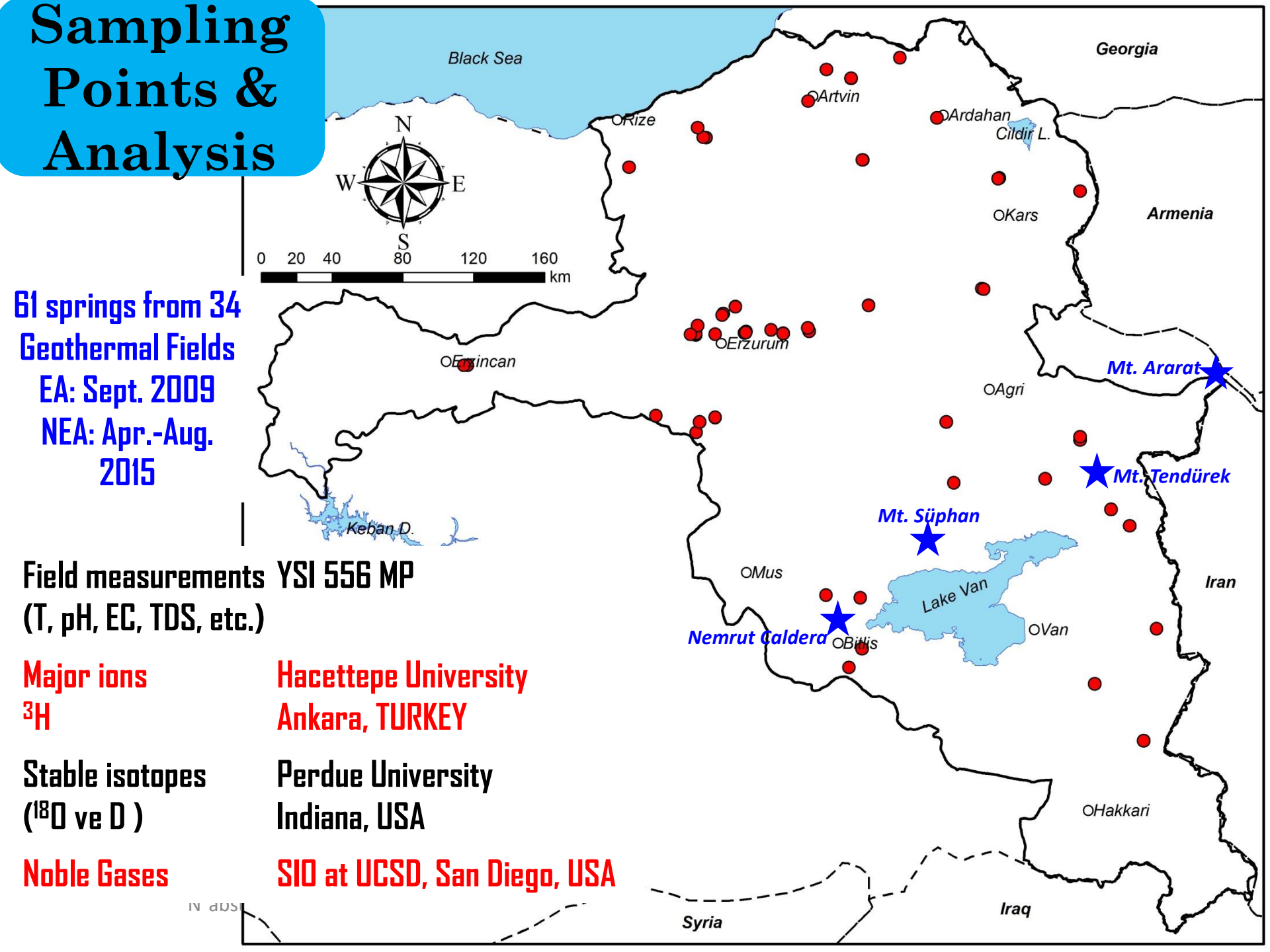
43rd IAH congress

Scope



In this study, we evaluate chemical and isotopic compositions of 34 geothermal fields in eastern Anatolia with emphasis on hydrochemical/isotopic characteristics and reservoir temperatures.

Sampling Points & Analysis



61 springs from 34 Geothermal Fields
EA: Sept. 2009
NEA: Apr.-Aug. 2015

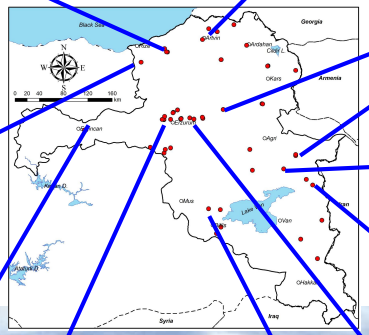
Field measurements (T, pH, EC, TDS, etc.)	YSI 556 MP
Major ions	Hacettepe University
^{3}H	Ankara, TURKEY
Stable isotopes (^{18}O ve D)	Perdue University
	Indiana, USA
Noble Gases	SIO at UCSD, San Diego, USA


55.1 °C
AYD


36.6 °C
COR


57.3 °C
HNG

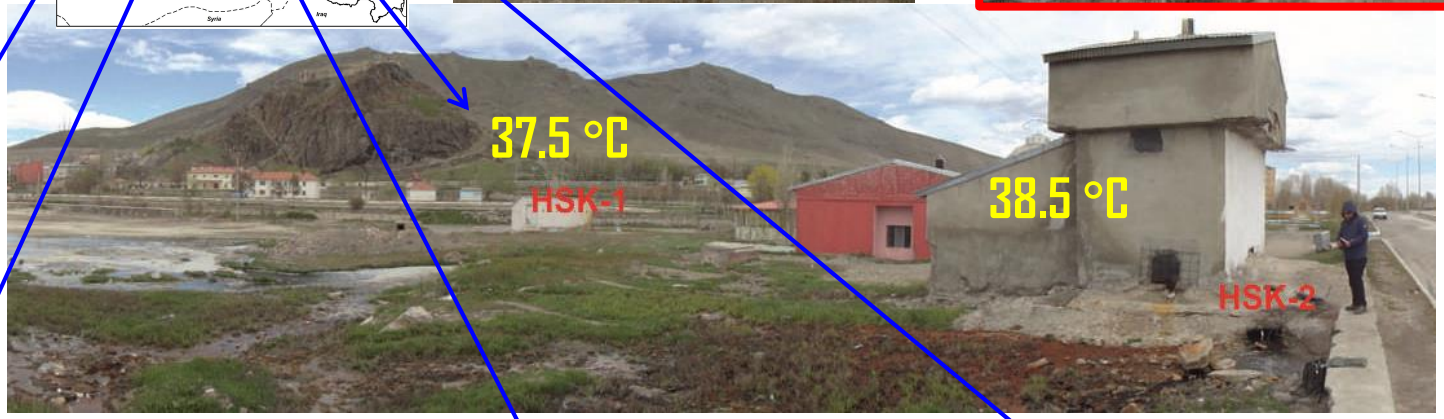

63.2 °C
IKI-1




DYD
(48.7 °C)


TAS
(81.3 °C)


21.6 °C
ERG


37.5 °C
HSK-1
38.5 °C
HSK-2


20.8 – 38.3 °C
GLG

Springs


CKR
(33.6 °C)


BUG
(25.1 - 34.4 °C)

Hydrogeochemistry

T

16.26 – 81.30 °C

pH

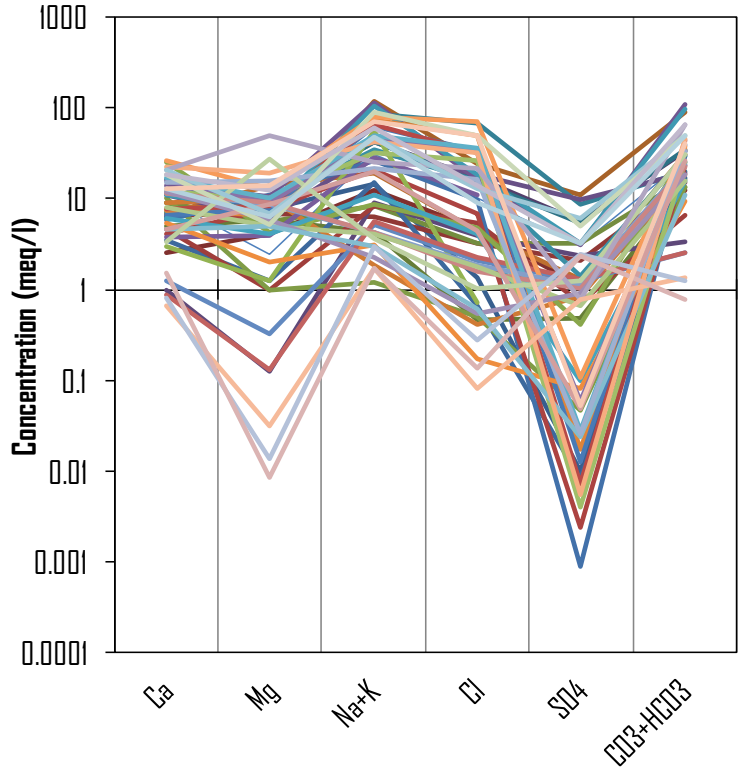
5.56 – 9.76

EC

320 - 16104 µS/cm

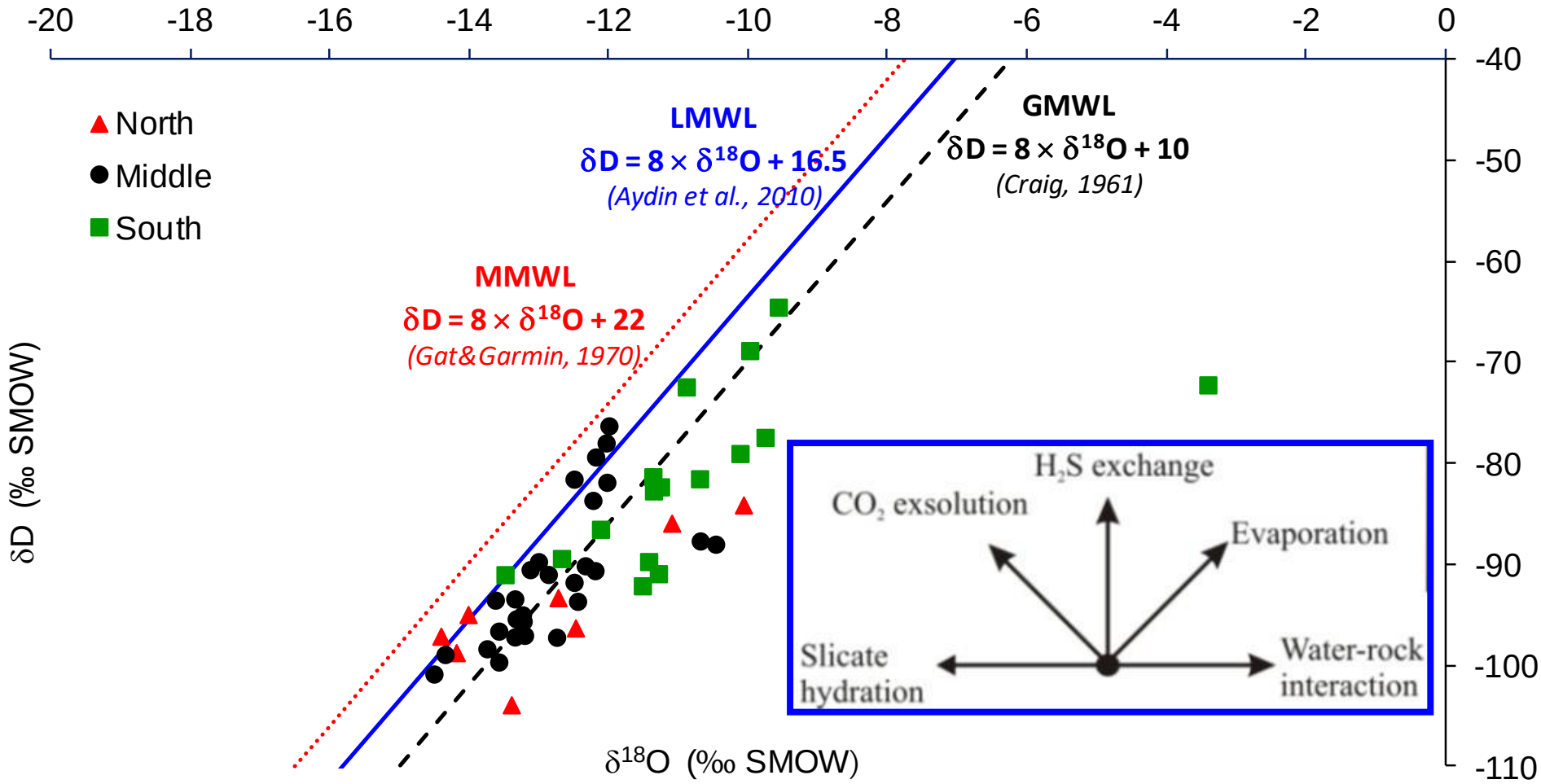
EC_{25}

203 - 10434 µS/cm



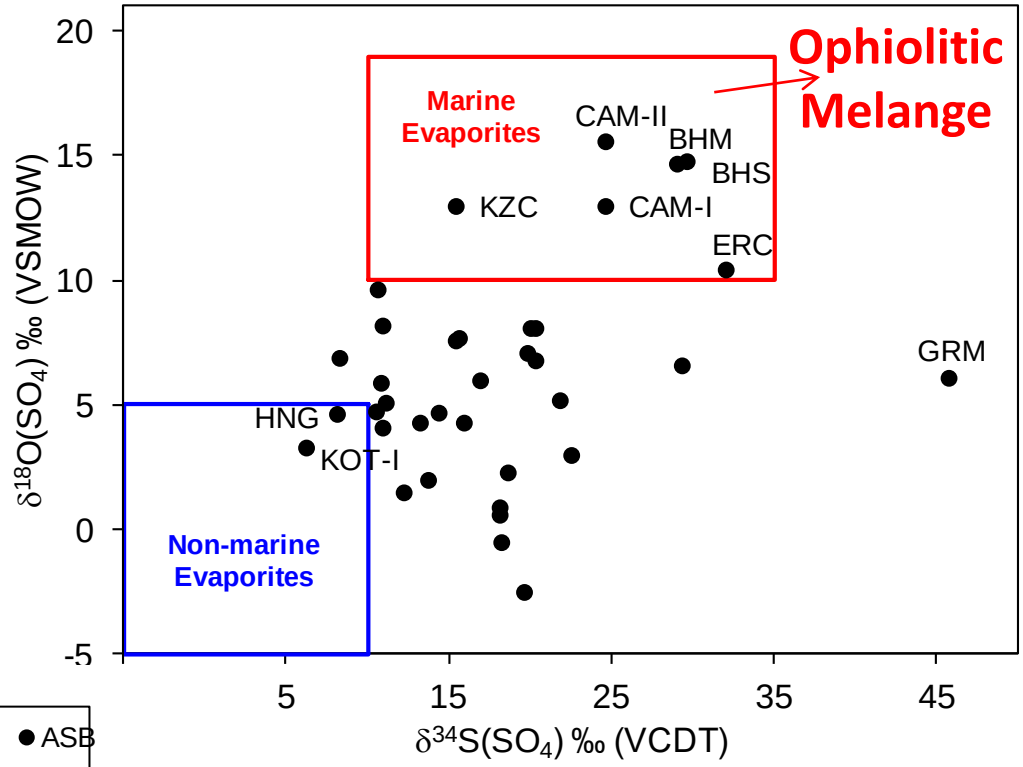
AYR AYS BUG
CAM 1 CAM 2 CAY
CKR DVT DYD
GRM HAD KOC
NHL PAT TAS-I
TAS-II TUT YUR
AKB AKK HOL
HNG HNS AZY
GLG HRM KRZ
KZT DLC KZC
BHM BHS ASB
HSK-I HSK-2 HSK-3
GOK-I GOK-II HAM
MEM OZD UZA
UZT ARZ EKS
ERC İKİ-I AYD
KML OTG COR
KOT-I KOT-2 SUS

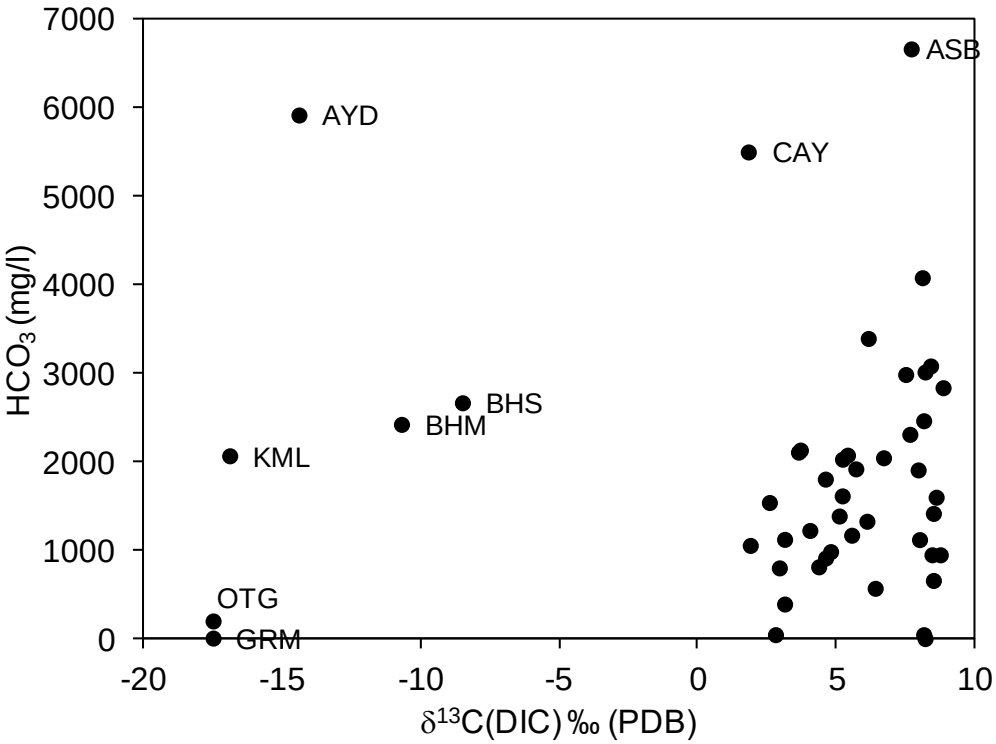
Environmental Isotope Compositions



	δD	$\delta^{18}O$	^{3}H
	(SMOW)		(TU)
Min	-103.89	-14.51	0.00
Max	-64.50	-3.41	3.22

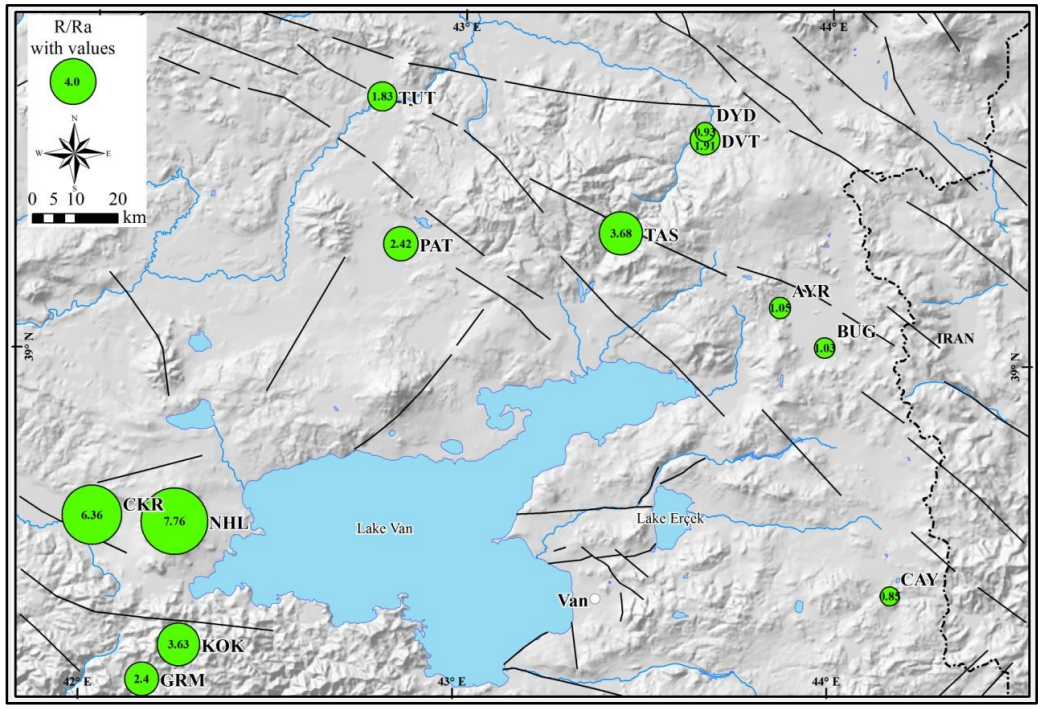
$\delta^{13}C(DIC)$, $\delta^{34}S(SO_4)$ & $\delta^{18}O(SO_4)$ Compositions





	$\delta^{13}C(DIC)$	$\delta^{34}S(SO4)$	$\delta^{18}O(SO4)$
	(PBD)	(VCDT)	(VSMOW)
Min	-17.50	6.20	-2.50
Max	8.85	45.70	15.60

He – C Compositions



Mantle-derived He

The three-component mixing model (Sano and Wakita, 1985)

West of Lake Van

$^3He/^4He$ 0.85 R_A – 7.76 R_A

Highest value at Nemrut Caldera (West of Lake Van)

Sample Location	Sample ID	$^3He/^4He$ R/R_A	Mantle-derived He (%)
Ayrancı-Çaldıran	AYR-1 (Gas)	0.96	11.9
Ayrancı-Çaldıran	AYR-2 (Gas)	1.05	13.0
Buğulu-Çaldıran	BUG (Gas)	1.03	12.8
Çamlık-Başkale	CAM (Gas)	1.00	12.4
Çaybağı-Saray	CAY (Gas)	0.85	10.6
Diyadin	DVT (Gas)	1.91	23.7
Patnos-Ağrı	PAT (Water)	2.42	30.1
Taşkapı -Erciş	TAS (Gas)	3.68	45.7
Tutak-Ağrı	TUT (Gas)	1.83	22.7
Yurtbaşı-Gürpınar	YUR (Gas)	0.86	10.7
	DYD (Gas)	0.93	11.6
Nemrut Caldera	NHL (Gas)	7.76	96.4
Çukur-Güroymak	CKR (Gas)	6.36	79.0
Kokarsu-Bitlis	KOK (Gas)	3.63	45.1
Germav-Hizan	GRM (Gas)	2.4	29.8

N°abstract **1992**

Conclusions

- The eastern Anatolia characterized by abundant geothermal activity occurring in the vicinity of post-collisional Neogene-Quaternary volcanics provides a potentially rewarding locality to examine the nature of mantle-derived fluids and the superimposed effects of crustal contamination.

- $^{3}He/^{4}He$ ratios of eastern Anatolia fluids vary over a wide range, from 0.85 R_A to 7.76 R_A indicating the presence of mantle-derived helium throughout the region.

- $\delta^{18}O$–δD compositions of eastern Anatolia waters consistent with a meteoric origin.

- The variability in $\delta^{34}S$ values is due to mixing of SO_4 from marine evaporates and from terrestrial evaporates.


Nemrut Caldera (2948 m asl) at West of Lake Van December 2011
The last eruptions of Nemrut occurred in 1692. The top of the volcano is a large caldera that hosts three crater lakes.
Thanks for your attention…
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