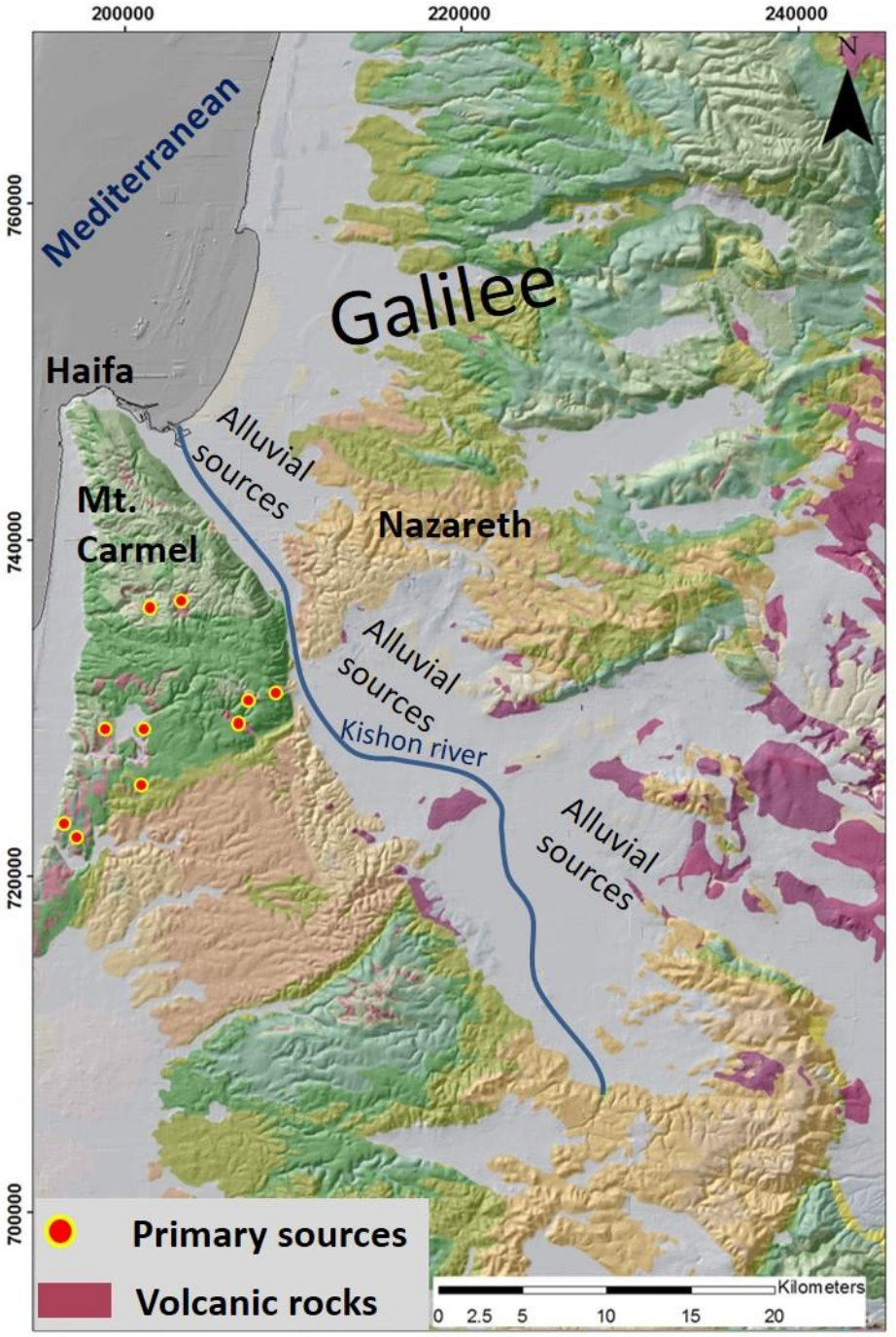
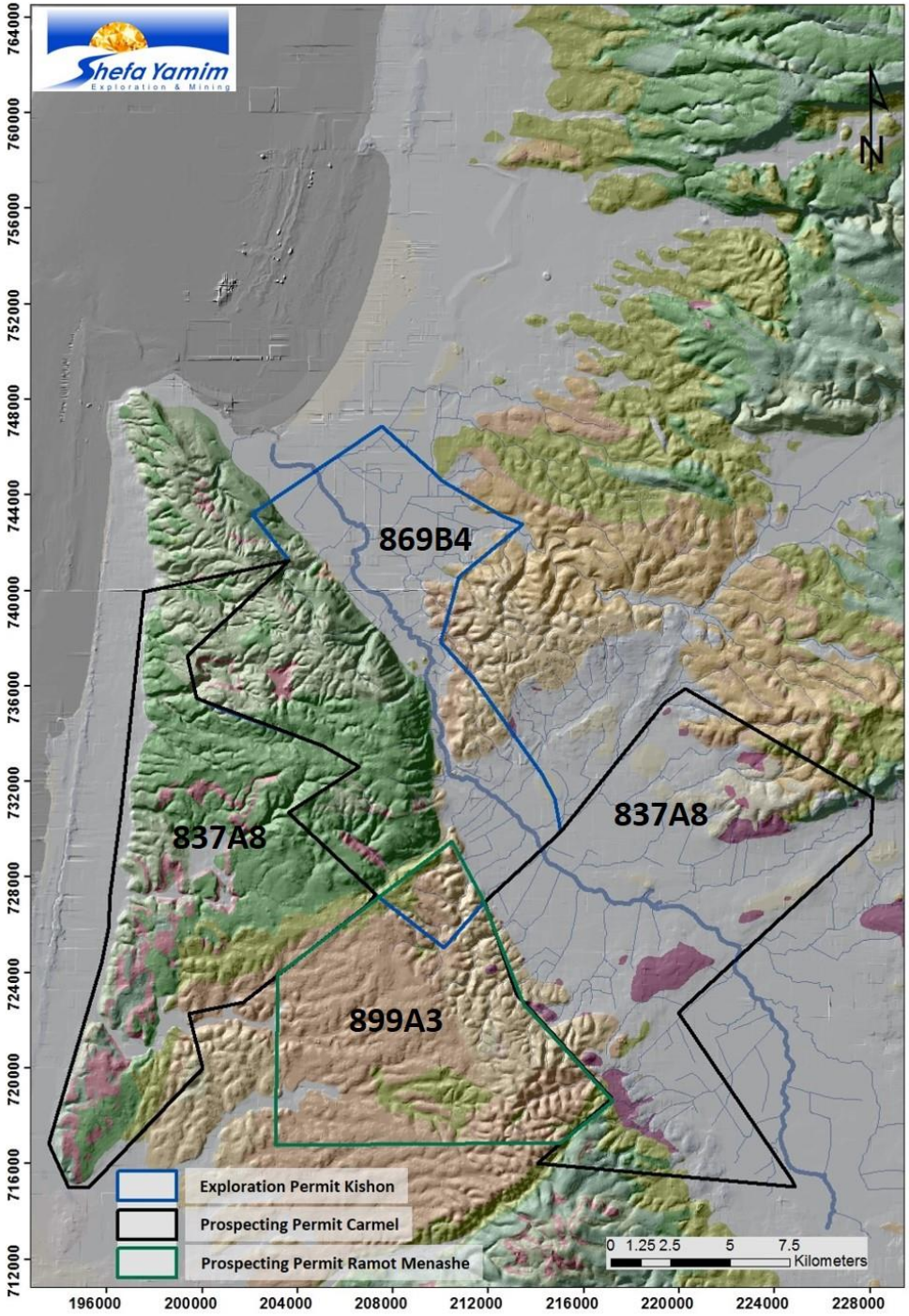
Geology and Exploration of Gem Deposits at Mt. Carmel, Northern Israel: *Natural Moissanite, Sapphire, Ruby & Diamond*

Howard Coopersmith,
Vered Toledo, John Ward, Michiel De Wit,
R Spaggiari, Emmanuel Fritsch

Northern Israel Geological map

- **Predominantly Cretacous Marine Sediments**
- **Younger Sediments**
- **Cretaceous Volcanic Rocks**
- **Neogene Basalts**
- **Cretaceous to recent Alluvials**

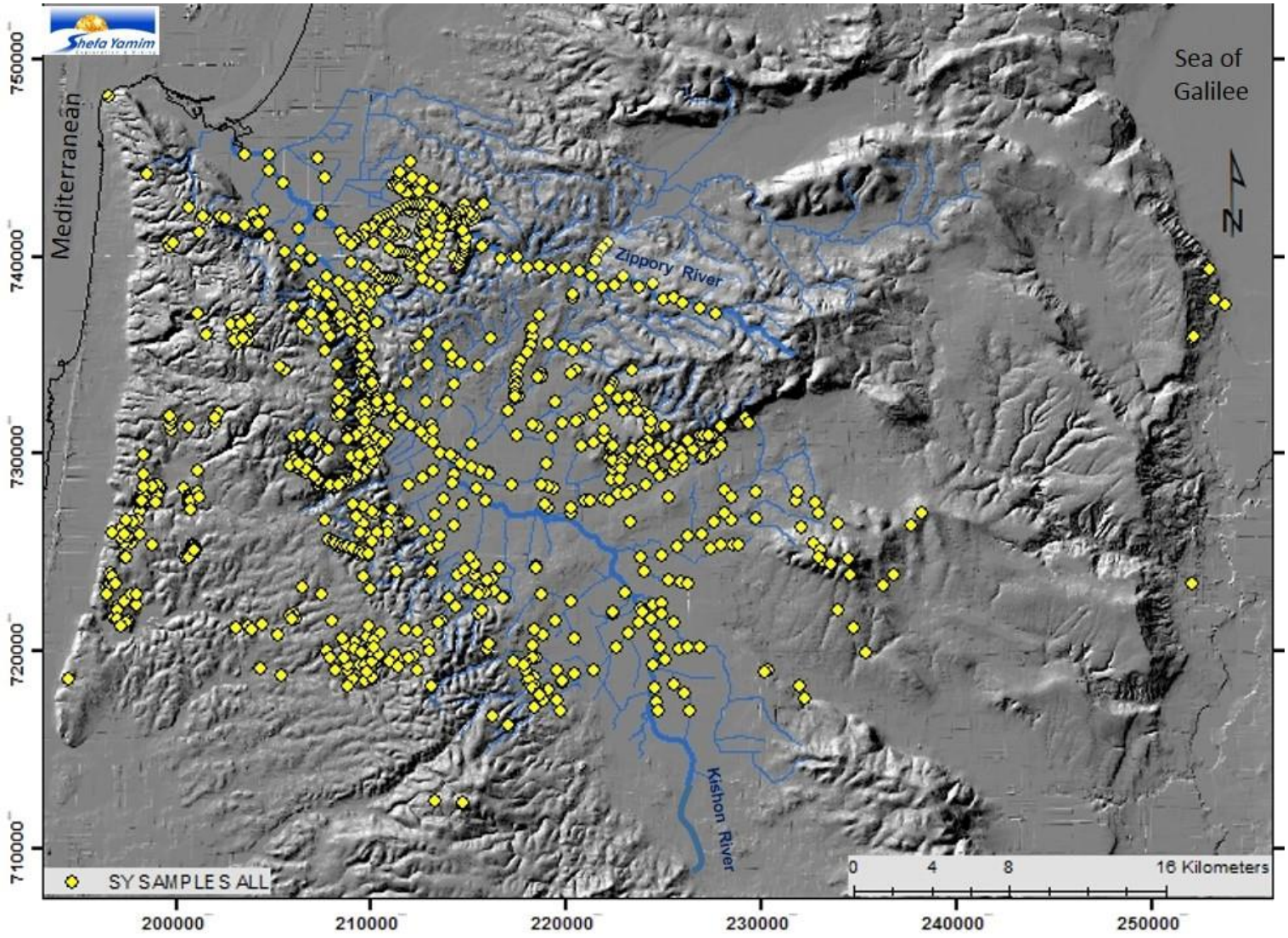




Shefa Yamim is exploring for Gem Mineral Deposits

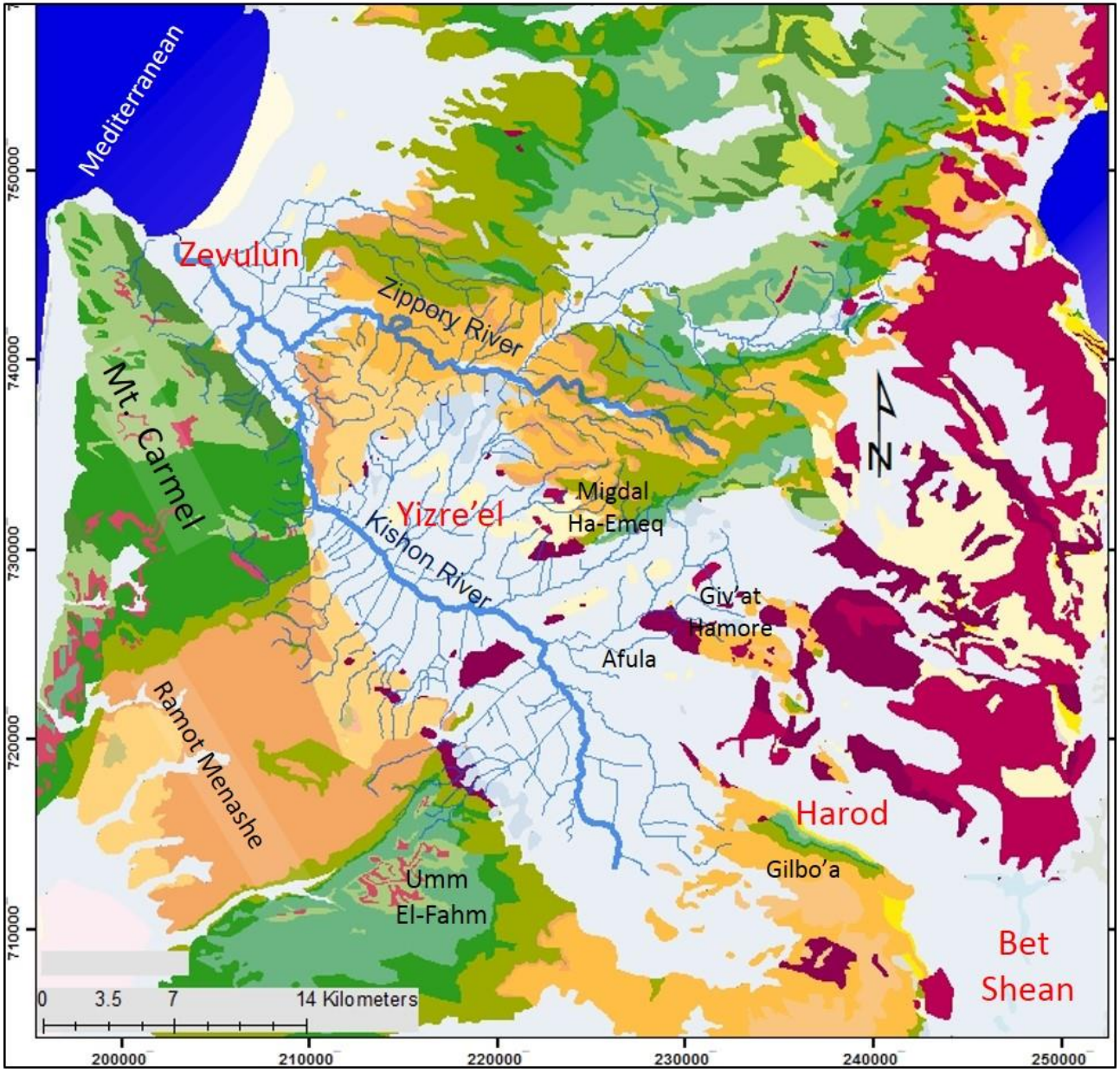
Current SY Exploration (869B4) and Prospecting permits (837A8 and 899A3) are shown

Digital Earth Model- Hall, 2005.
Geological map- Sneh *et al*., 1998



Area Explored through Heavy Mineral Prospecting

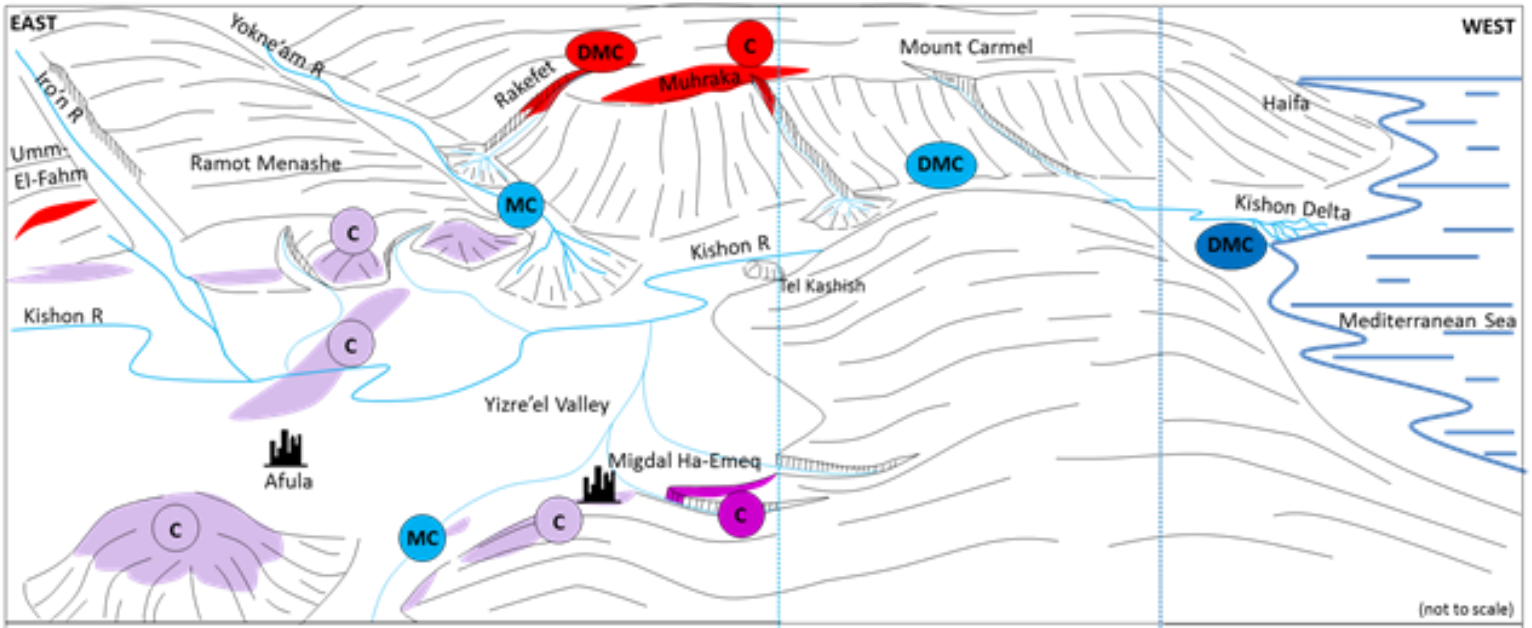
SY sampling locations (total of 1,127 samples to date)



(background geology adapted from Sneh, *et al*., 1998)

Source to Sink Geological Model

Geological model in 3D view. Note the 3 fold division of the Kishon catchment.
The model is a guideline to placer exploration in the Kishon catchment.



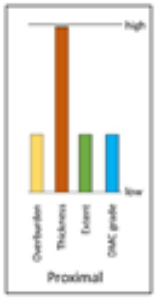
KISHON DRAINAGE: PROXIMAL REACH

- Alluvial fans, small streams and wide valley
- Limited placer development
- MC
- Volcanics in Kishon catchment:

Cover Basalts – Source of Corundum C

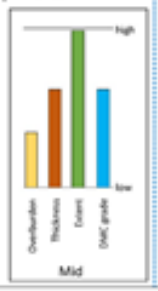
Miocene Basalts underlying Yizre'el Valley and around rim of Kishon drainage basin - Source of Corundum C

Late Cretaceous volcanics - Source of Diamond, Moissanite & Corundum DMC



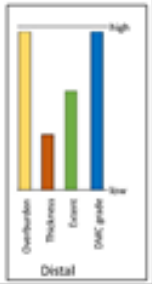
KISHON DRAINAGE: MID REACH

- Structurally-controlled
- Constricted fluvial reach with coarse fan gravel input from Mt Carmel in narrow valley
- Good placer development
- DMC



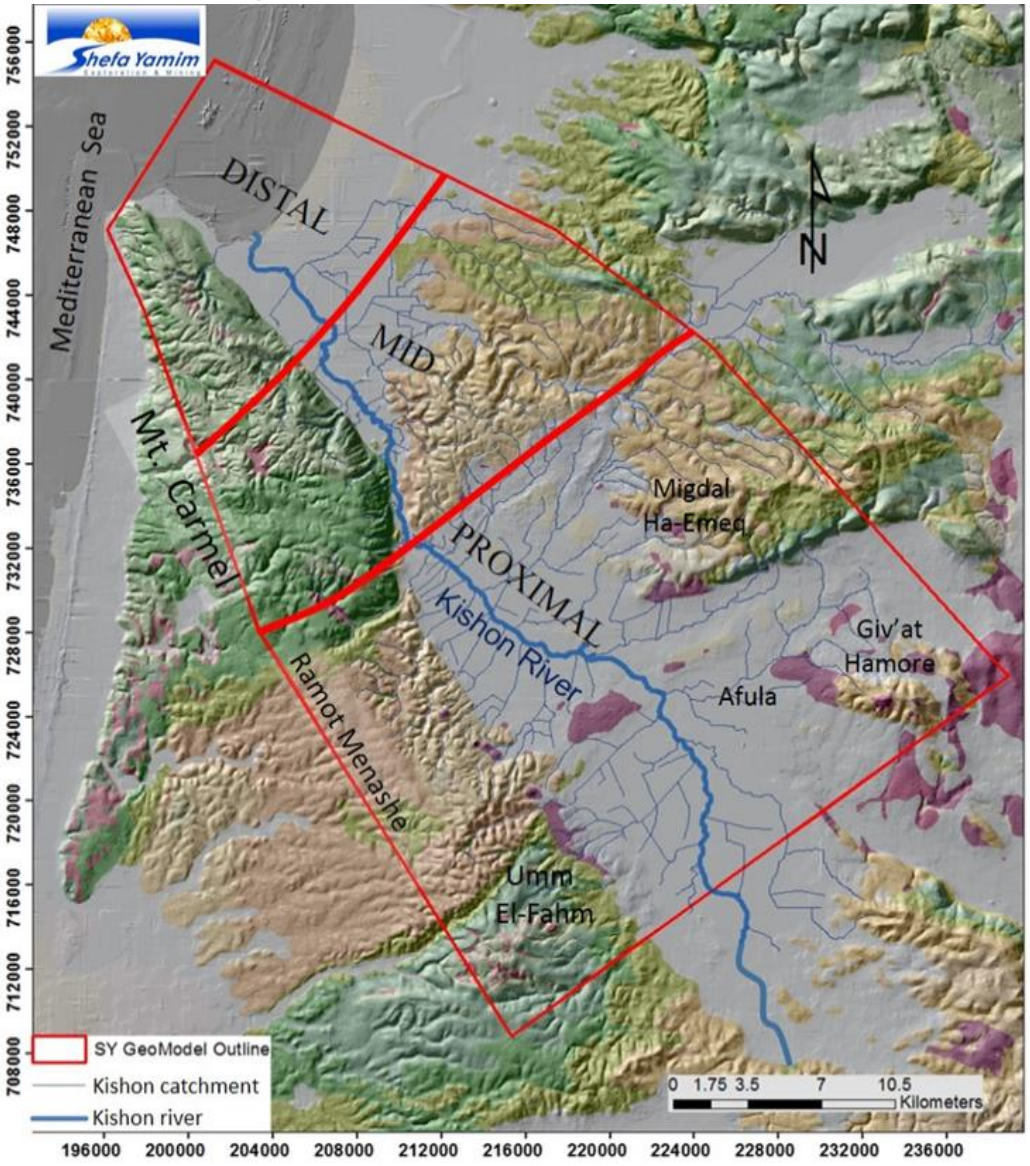
KISHON DRAINAGE: DISTAL REACH

- Fluvial / Marine interface
- Eustatically influenced
- Best placer development because of marine reworking
- DMC



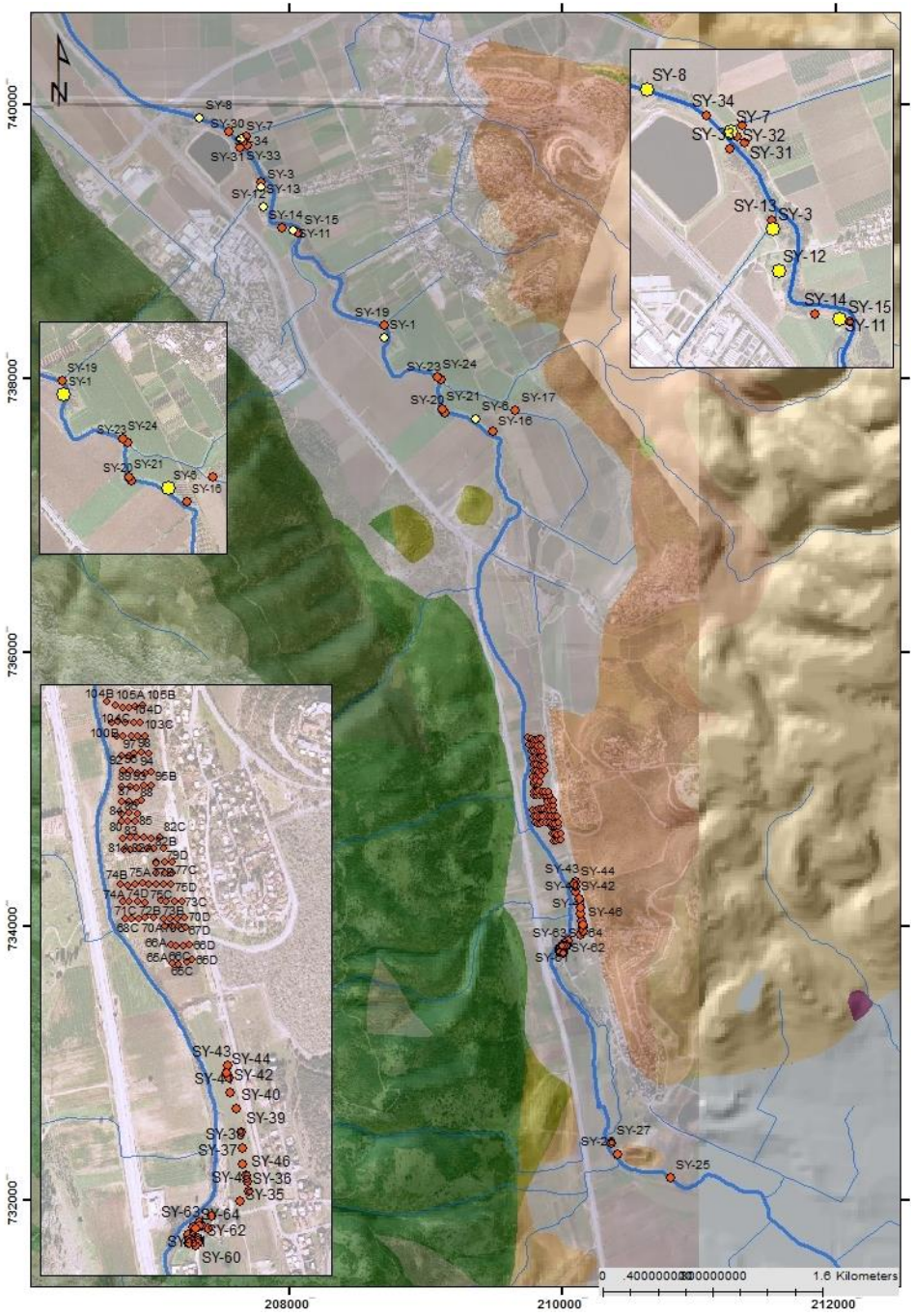
Shefa Yamim Alluvial Geological Model

- Map view of model extent

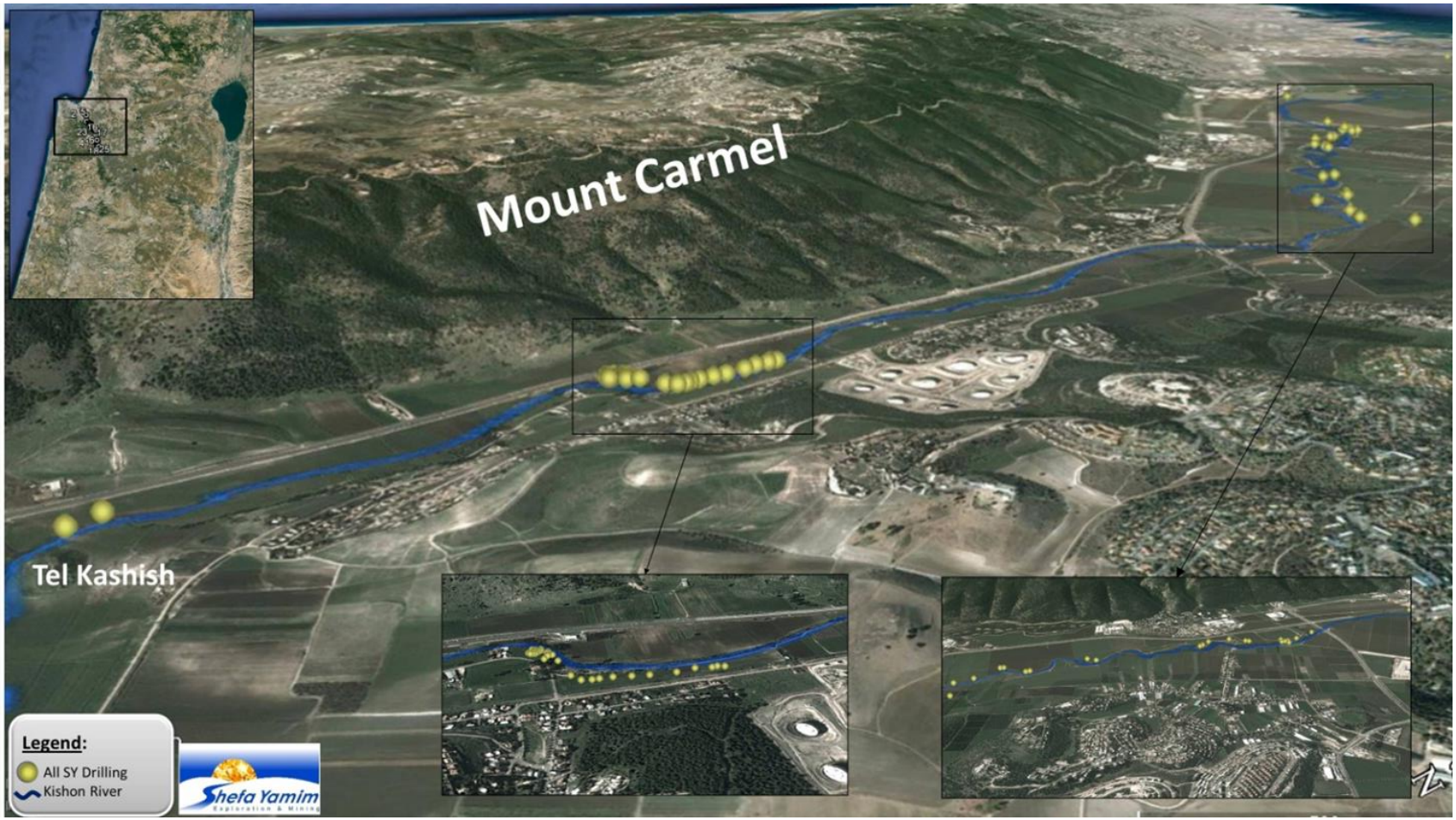


Placer Sample Locations

- **Kishon River**
- **Large Diameter Drilling**
- **Core Drilling**
- **Geologically Logged**
- **Bulk Samples**
- **Minerals Recovered**

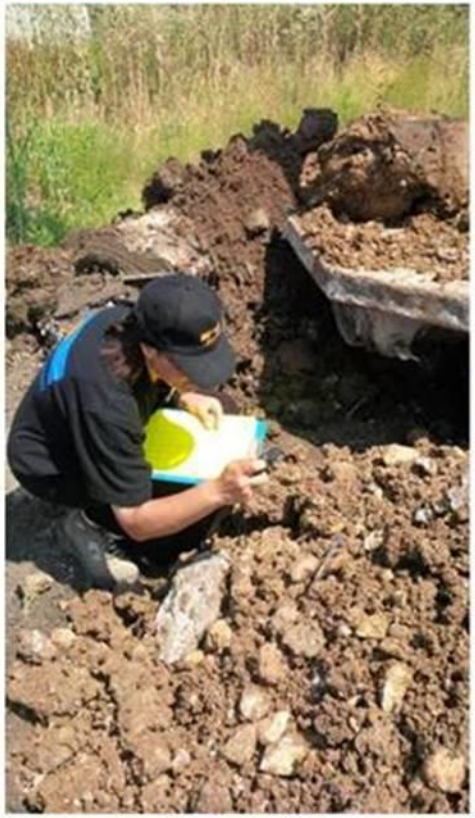


Kishon River Drainage



Kishon Bulk Sample

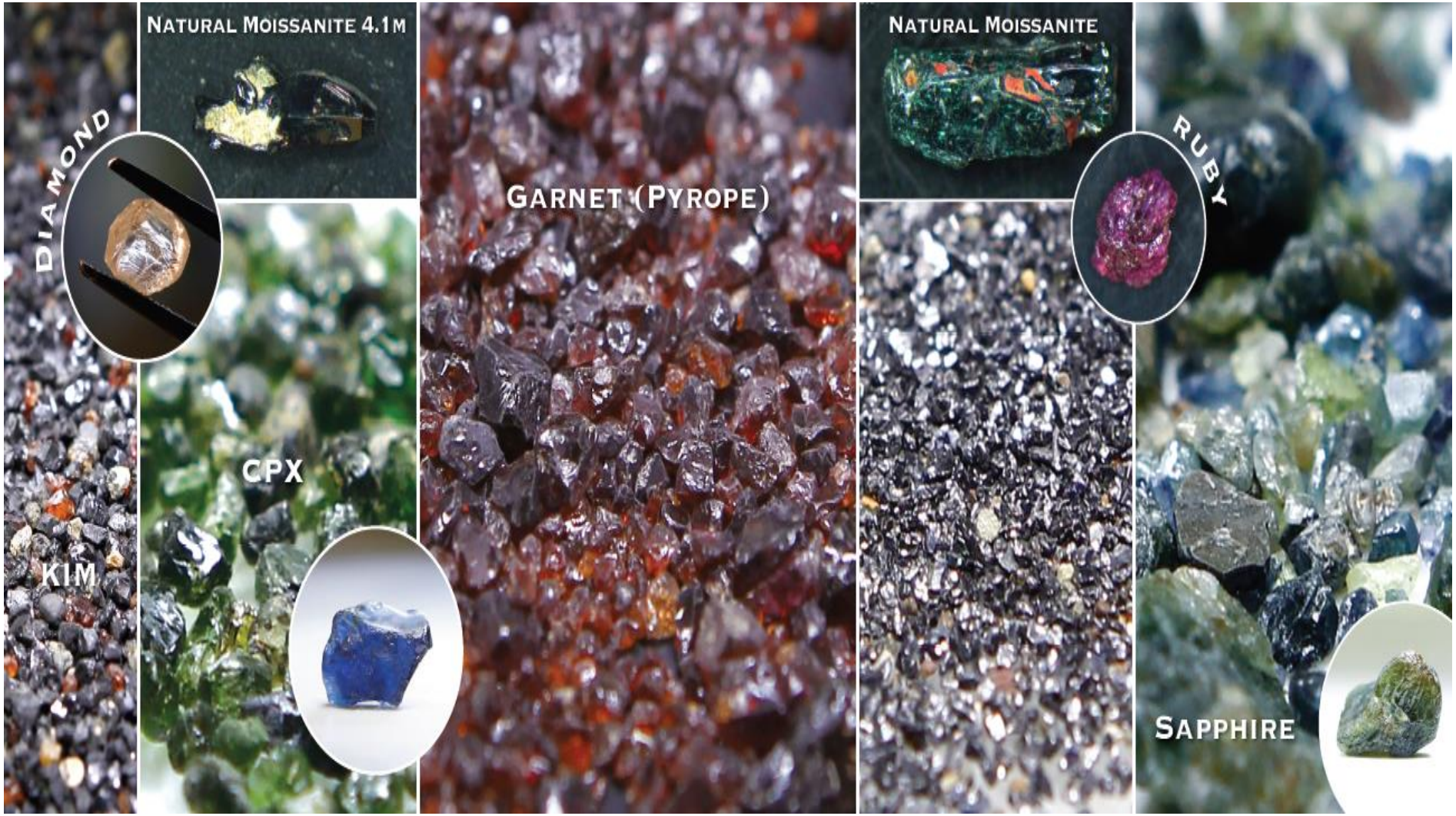
Kishon Large Diameter Drilling



Kishon River Placer Minerals

- **Economic Mineralization Targets**
  - **Diamond, Natural Moissanite, Corundum (DMC)**
- **Accessory Heavy Minerals**
  - **Garnet, Ilmenite, Zircon, Rutile, Pyroxene, Amphibole, Olivine, Spinel, Kyanite, FeTi Alloy**
- **Likely Derived from Mafic Volcanics**
  - **Volcanics contain Mantle Xenoliths**
  - **Indications of Deep, High Pressure Phases**

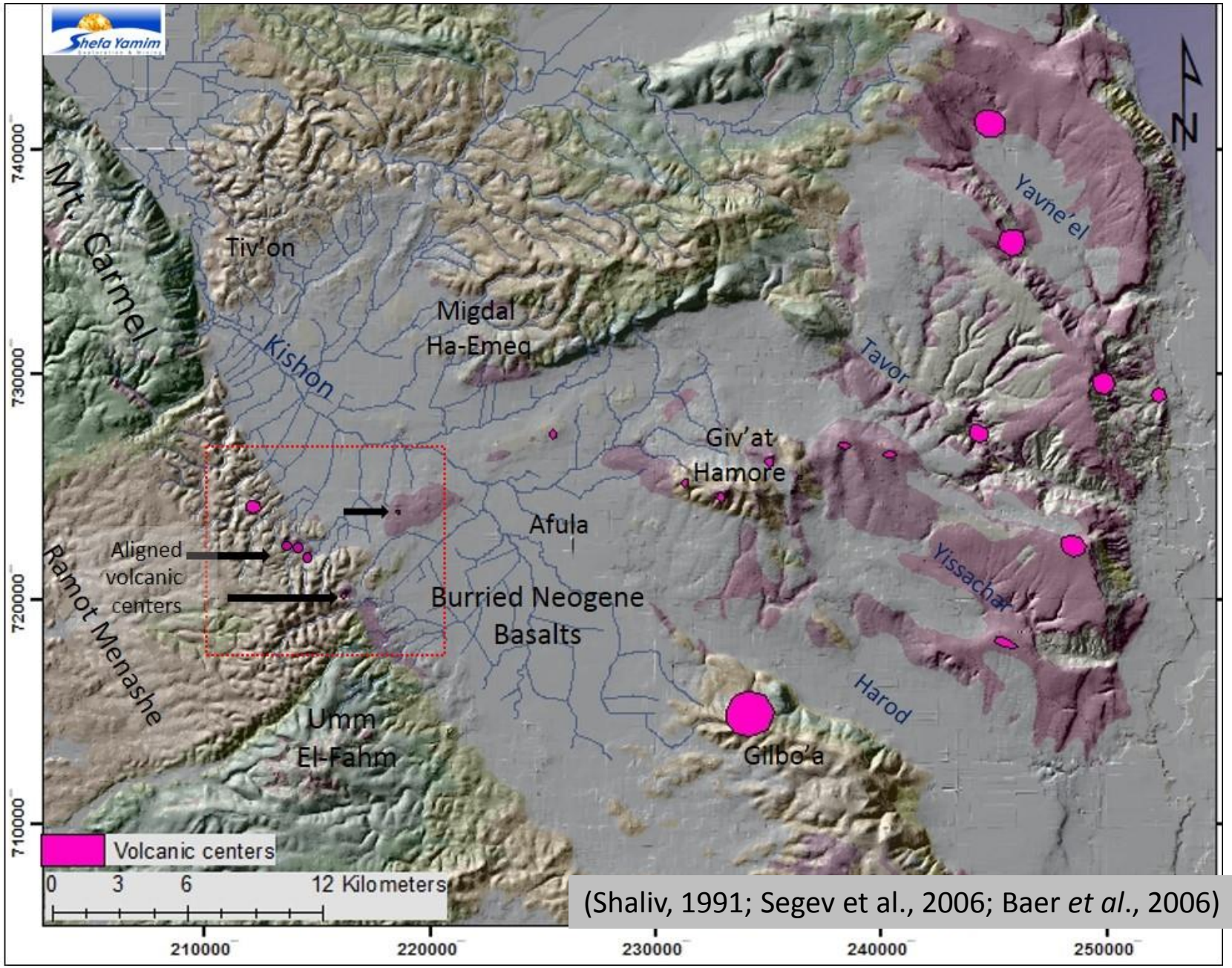
Recovered Minerals



Mt. Carmel Corundum

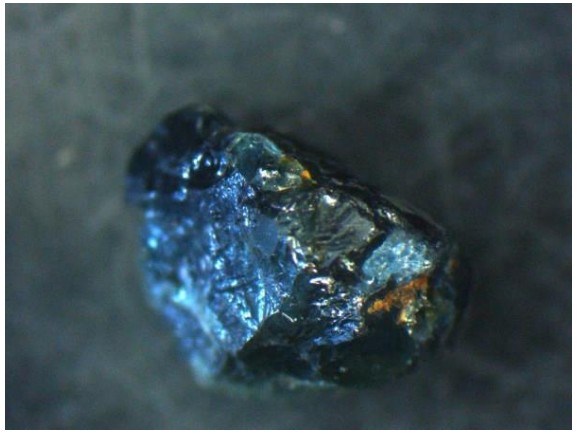
- Ruby
- Sapphire
- To 5.8 carats so far
- Xenocrysts in Volcanic Pipes and in Basalts
- Inclusions are being studied and may give clues as to origin

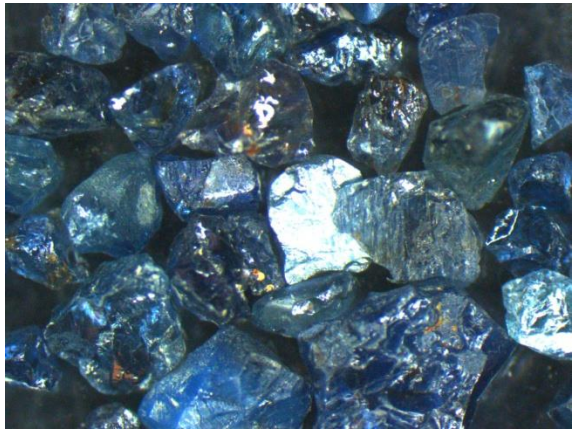
Volcanic centers as sources for alluvial corundum

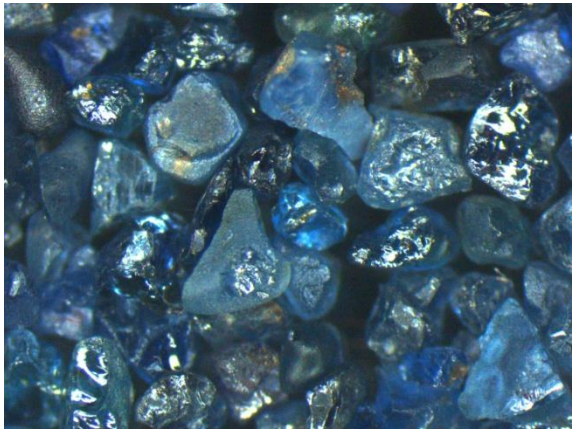


(Shaliv, 1991; Segev et al., 2006; Baer *et al*., 2006)

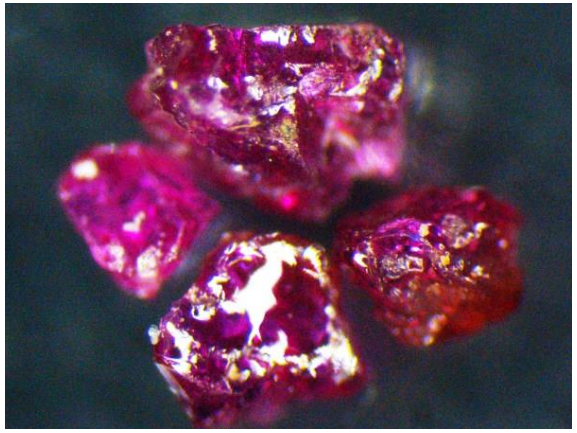
Sapphire

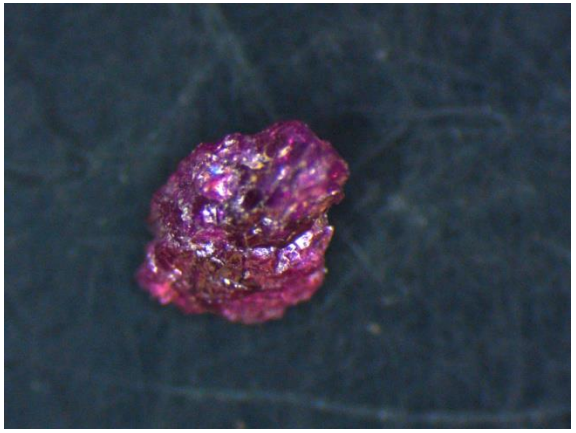
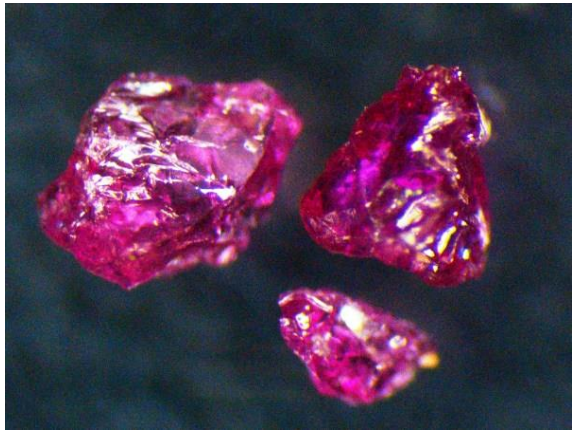
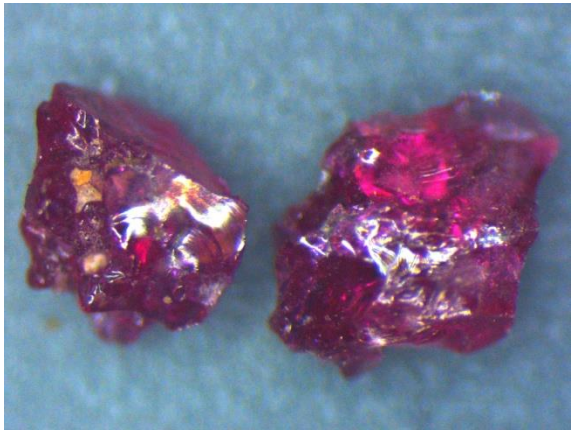
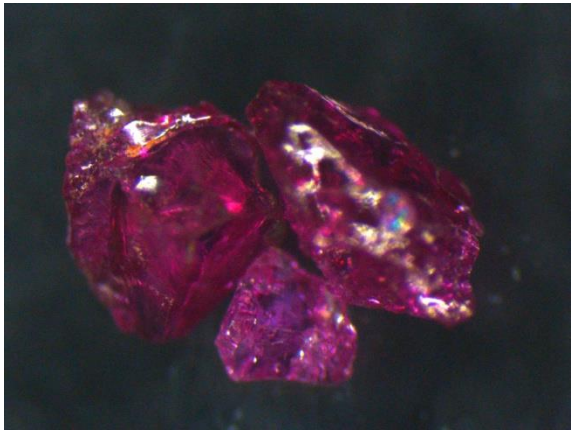




Ruby



Sapphire and Ruby analyses by Laser Ablation – Inductively Coupled Mass Spectrometry (LA-ICPMS)

- Sarah Gain & Bill Griffin

Sapphires - variations by colors

- Average trace element concentrations (ppm ± 1σ):
  - FeO = 1.04% ± 0.29
  - Si = 1478 ± 133
  - Ti = 280 ± 251
  - Cr = 260 ± 586
  - Ga = 158 ± 69
  - Mg = 88 ± 93
  - V = 61 ± 118
  - P = 29.7 ± 3.8
  - B = 2.0 ± 0.5
  - Mn = 1.2 ± 1.0
  - Zn = 1.0 ± 1.3
  - Cu = 0.14 ± 0.07

Natural Moissanite

- Primarily known as microscopic grains as inclusions in other minerals – less than 0.5mm
- Discrete Grains extremely Rare
- No Commercial Value to these tiny Grains

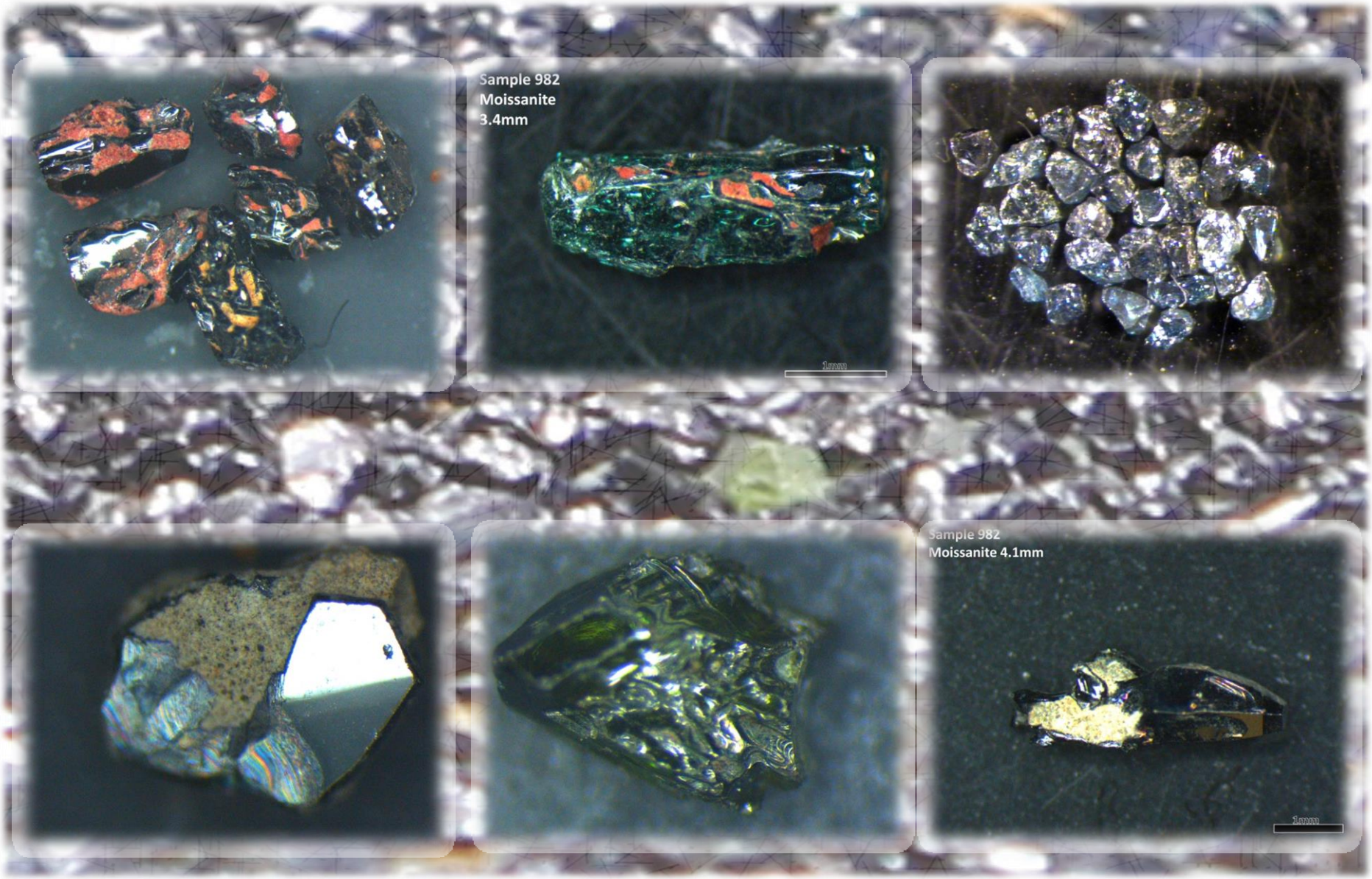
UNTIL

- **New Discovery of Abundant & Large Grains**
  - **Carmel Mountain area of northern Israel**

Carmel Mtn. Moissanite

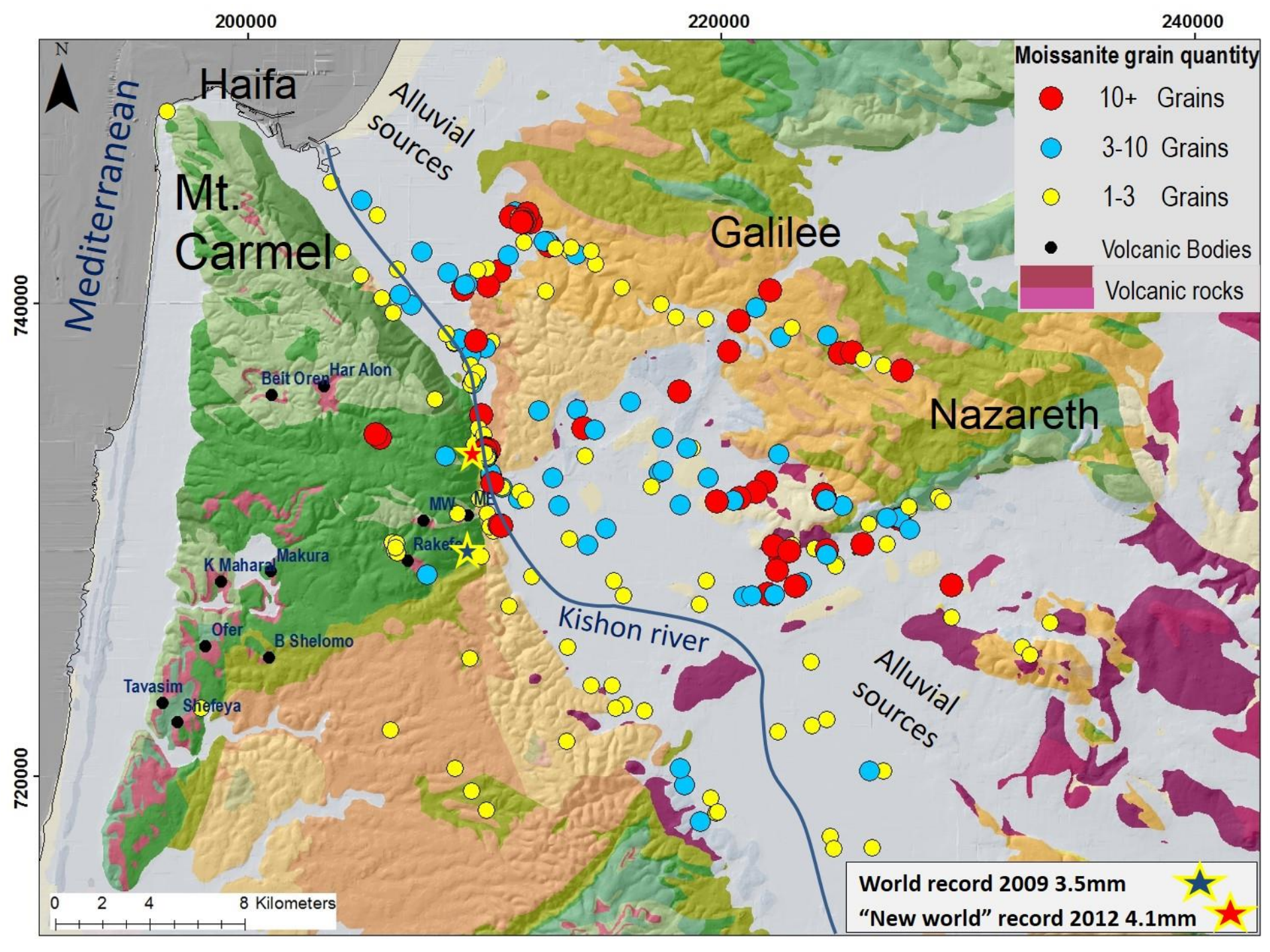
- Hardrock in Volcanic Rocks
- Valley Deposits in Alluvium derived from rock
  - Placer Deposits identified and sampled
  - Drill and Pit Sampling
- Discreet Grains <0.5 mm to **4.1** mm
  - ***World Record Sizes***
- **Gem Quality**, mostly deep Blue, some Green
- Confirmed by modern Gemological techniques

Moissanite


Sample 982
Moissanite
3.4mm
1mm
Sample 982
Moissanite 4.1mm
1mm

Natural Moissanite 4.1mm

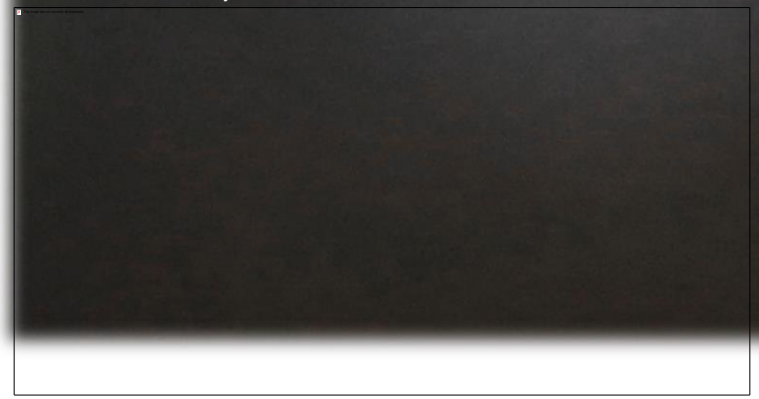
Mt. Carmel, Israel
Moissanites


200000
220000
240000
740000
720000
N
Haifa
Mediterranean
Mt.
Carmel
Alluvial
sources
Galilee
Nazareth
Moissanite grain quantity
10+ Grains
3-10 Grains
1-3 Grains
Volcanic Bodies
Volcanic rocks
Beit Oren
Har Alon
MW
ME
Rakefet
K Maharal
Makura
Ofer
B Shelomo
Tavasim
Shefeya
Kishon river
Alluvial
sources
0 2 4 8 Kilometers
World record 2009 3.5mm
"New world" record 2012 4.1mm

Diamonds recovered (77 diamonds in total mostly alluvial), **including 0.88 carat Gem (middle) Diamond.**

One Micro-Diamond in-situ

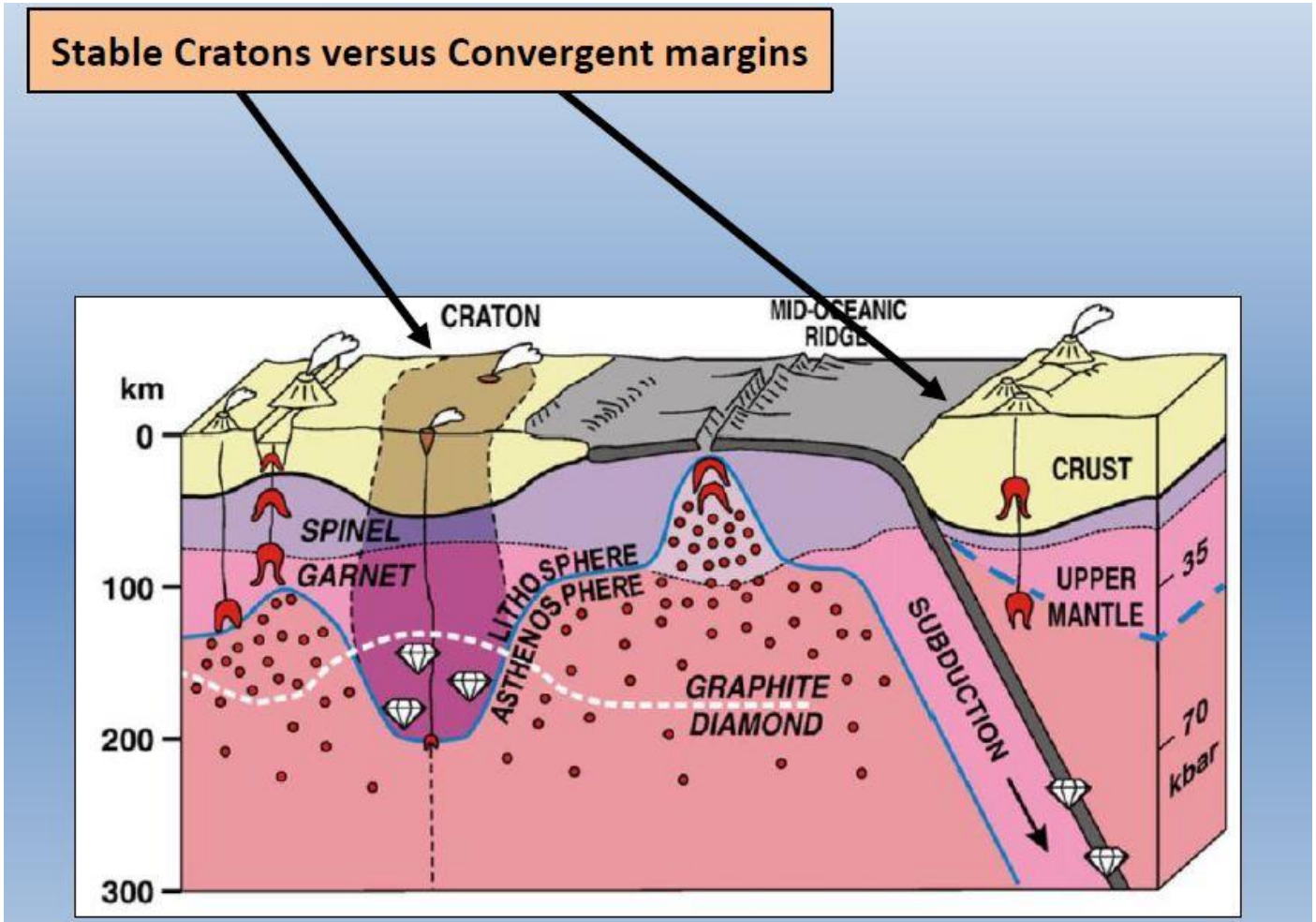
One micro diamond in-situ in volcaniclastic rock (De Beers, MiDa 2004)



Rakefet Volcaniclastic Complex

- **Vents and Pyroclastic Deposits**
- **Kimberlitic in appearance**
- **Kimberlitic Indicator Minerals**
- **Source for High Pressure Minerals & Gem Minerals**

Convergent Margin Volcanic Emplacement of Deep Minerals at Mt. Carmel



CONCLUSIONS

- **New Gem Occurrence being developed**
- **Important discovery of true Natural *Moissanite – "large" & abundant***
- **Minerals carried from depth in convergent plate arc volcanics, eroded into Alluvial environment deposits**
- **Shallow *Peridotitic* lithosphere and Deeper *Eclogitic* component?**
- **Paragenesis is being studied**