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POLYPHASE TECTONICS AS A TOOL FOR EXPLORATION OF CHROMITE ORES HOSTED BY ULTRAMAFIC ROCKS OF BULQIZA ULTRAMAFIC MASSIF, ALBANIA©

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Regional geological setting showing the **External zones**,

the western ophiolite belt (central Dinaride, Mirdita, Hellenic ophiolites),

the Internal zones (Korabi-Pelagonian Microcontinent = Pelagonian zone, Korab zone, Drina-Ivanjica element) and

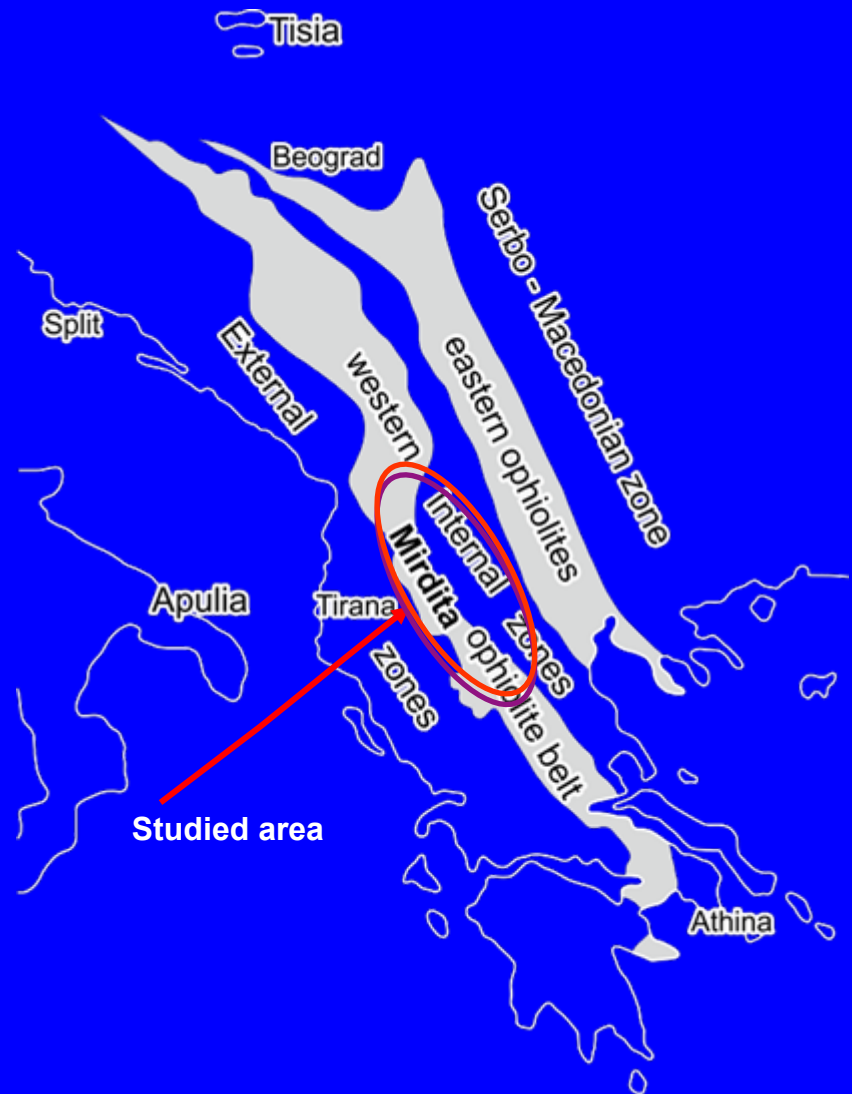
the eastern ophiolites (Inner Dinaric ophiolite belt and Vardar zone).

Kiliyas et al. 2010 distinguishes:

One group of authors (Mountrakis,1986; Robertson et al., 1996; Robertson and Shallo, 2000; Stampfli and Borel, 2002; Brown and Robertson, 2004; Sharp and Robertson, 2006; Rassios and Moores, 2006; Karamata,2006) **reconstructs Pelagonian/Korabi-Pelagonian units as a continental block that was bordered by two Tethyan oceanic realms**

In contrast another group of authors (Mercieret al., 1975; Burchfiel, 1980; Hoxha, 2001; Bortolotti et al., 2005; Gawlick et al. 2008; Schmid et al., 2008) **favours a single oceanic basin to the east, the Tethys (Vardar/Axios) Ocean**

About the displacement direction of the obducted ophiolites during Middle to Late Jurassic time onto the Pelagonian Continent : **E- to NE-ward direction** (e.g. Robertson and Shallo, 2000; Rassios and Dilek, 2009) or **W- to SW-ward direction** (e.g. Jacobshagen et al., 1978; Vergely, 1984; Hoxha, 2001; Gawlick et al., 2008; Schmid et al., 2008 or both e.g. Mountrakis, 1986; Sharp and Robertson 2006).



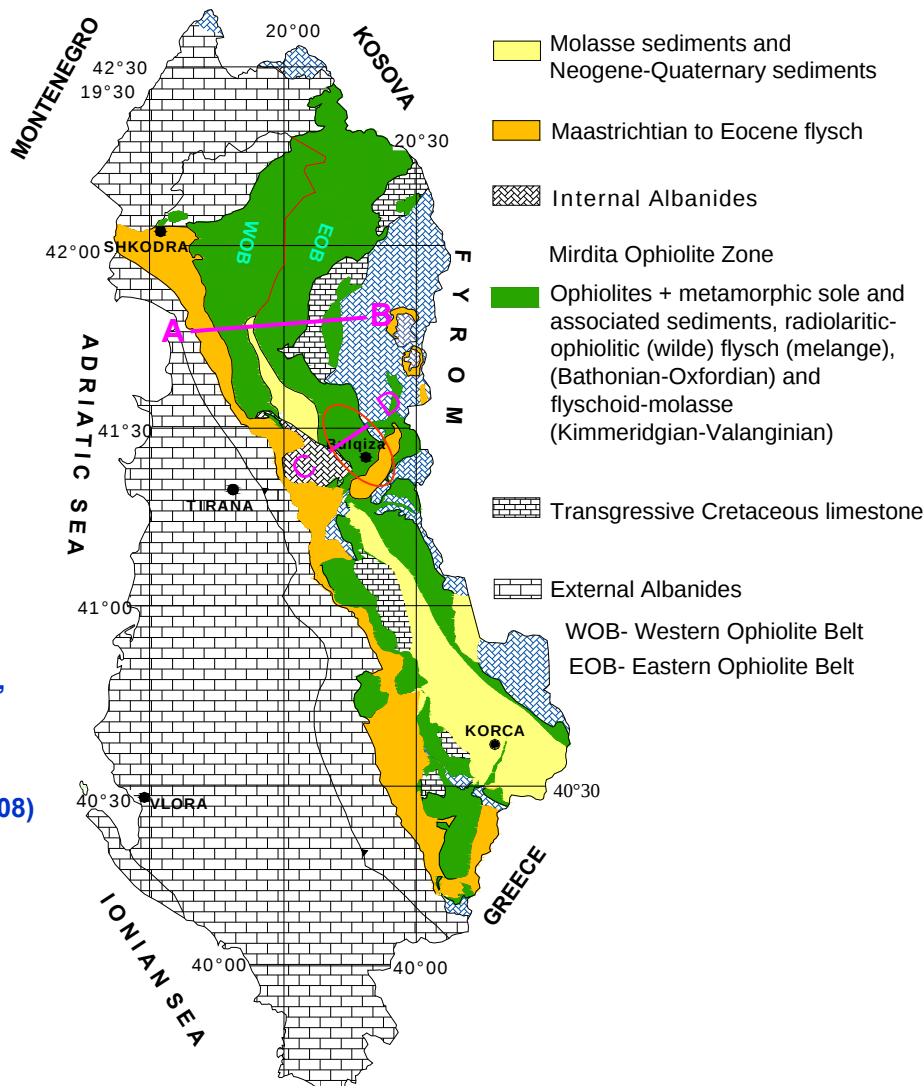
Gawlick et al. 2008

The Albanian ophiolites of the Mirdita Zone represent remnants of Mesozoic oceanic lithosphere within the Dinaride-Albanian-Hellenide segment of the Alpine orogenic system.

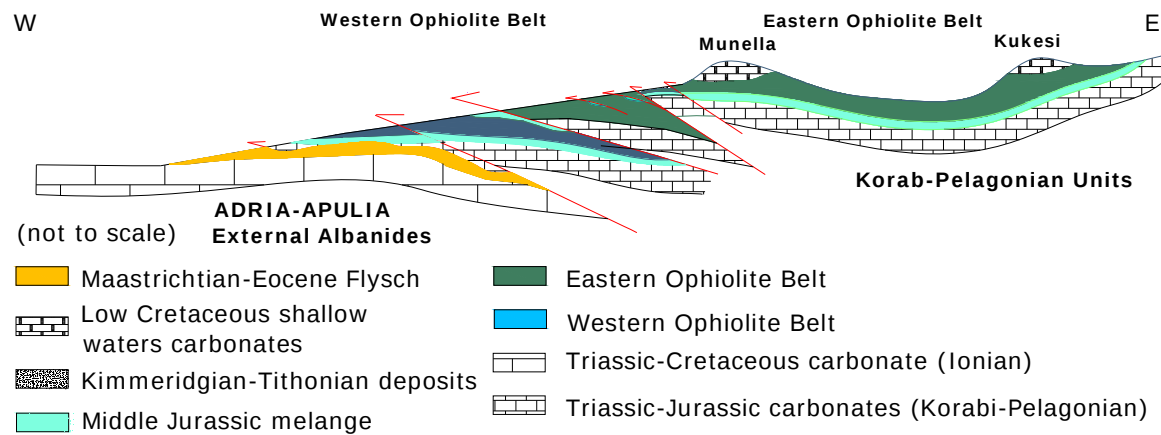
Most recent studies (Shallo & Dilek 2003; Dilek and Flower 2003; Bortolotti et al. 2005, 2006; Dilek et al.2008) distinguish two different rock associations, forming the **Western Ophiolite Belt (WOB)** and **Eastern Ophiolite Belt (EOB)**.

The upper mantle of **WOB** includes lherzolite-harzburgite, plagioclase lherzolite, plagioclase dunite and plutonic complex, overlain by extrusive sequence of MORB affinity whereas

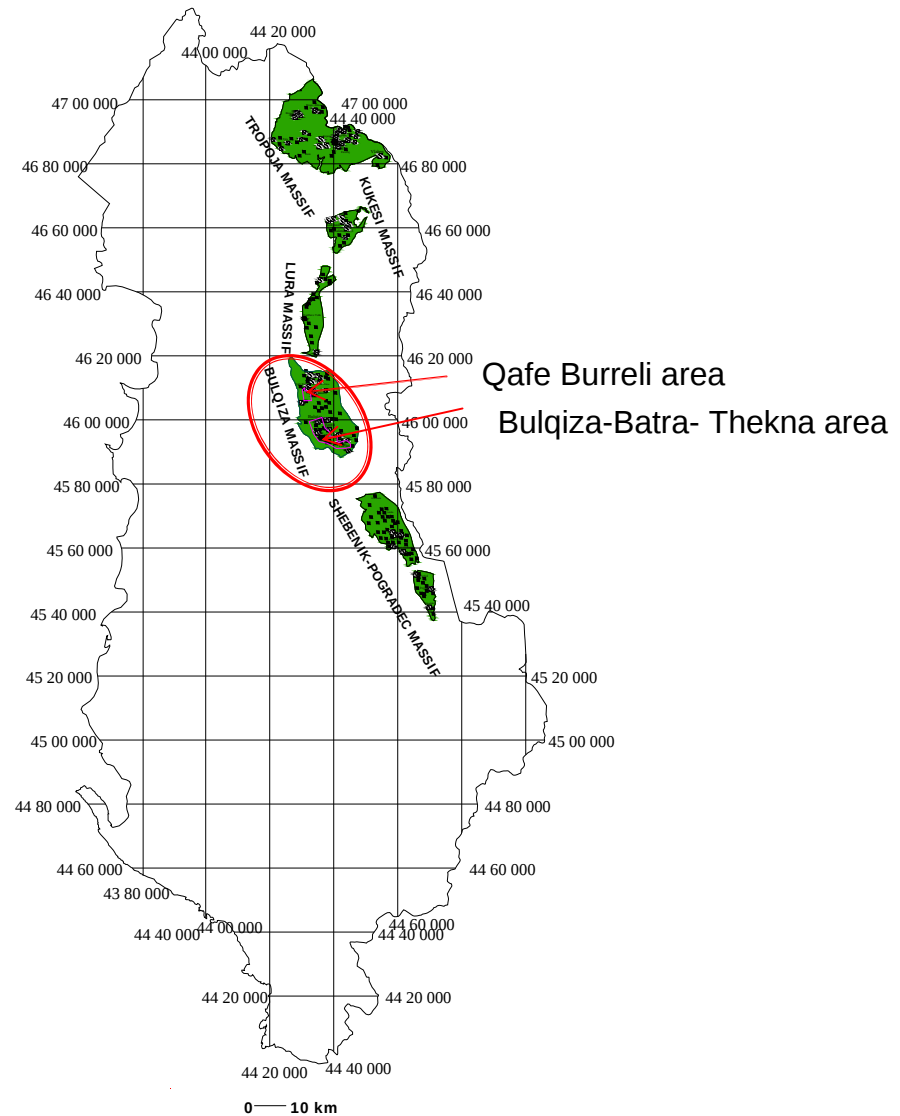
the upper mantle of **EOB** includes tectonized harzburgite and dunite, as well as ultramafic cumulates including olivine clinopyroxenite, wehrlite, olivine websterite, and dunite forming a transitional Moho and plutonic complex overlain by extrusive sequence of basalts-andesites-dacites and rhyolites indicating SSZ affinity (Dilek et al.2008)



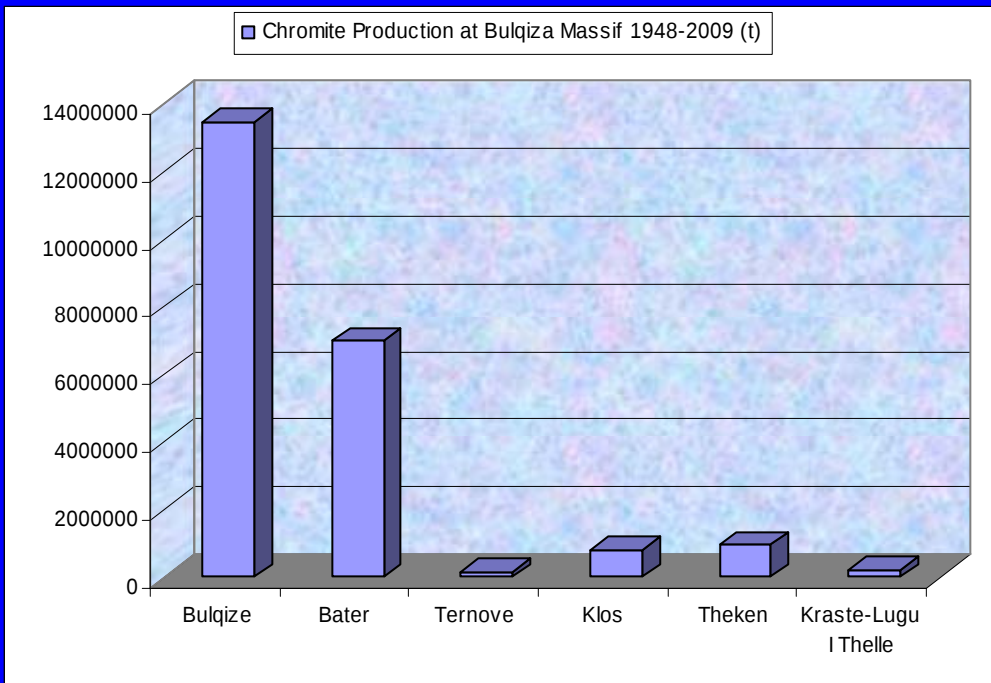
Simplified after Geological Map of Albania, 2002



**Generalized cross-section A-B Western Ophiolite Belt-Eastern Ophiolite Belt
(with metamorphic sole and melange) relationships After Hoxha at Gawlick et al..2008**



Simplified after Metalogenic Map of Albania (ISPGJ-FGJM, 1989) showing the ultramafic massifs of Eastern Ultramafic Belt with main chromite deposits



Chromite Production at Bulqiza Massif (1948-2009)

Bulqize 13490323

Bater 6992843

Ternove 175301

Klos 790504

Theken 949000

**Kraste-Lugu I
Thelle 231296**

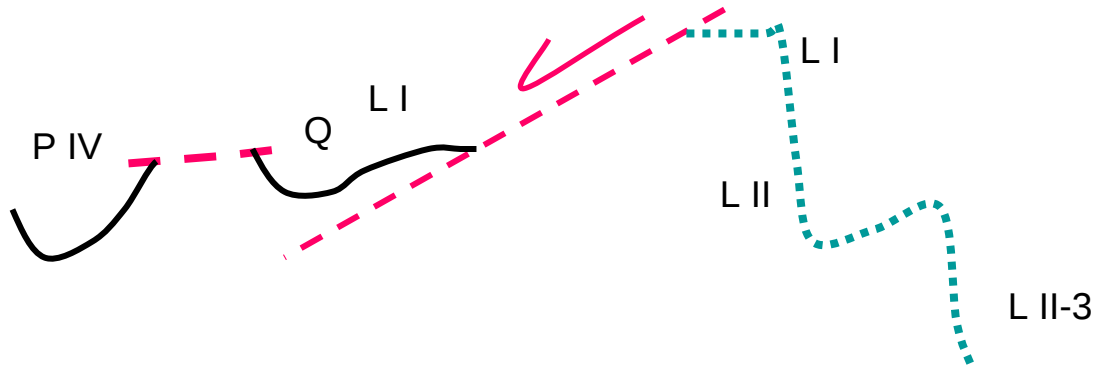
Total 22 629 267 @ 40% Cr₂ O₃*

Chromite production Bulqiza-Batra-Thekna area 1948-2009 years

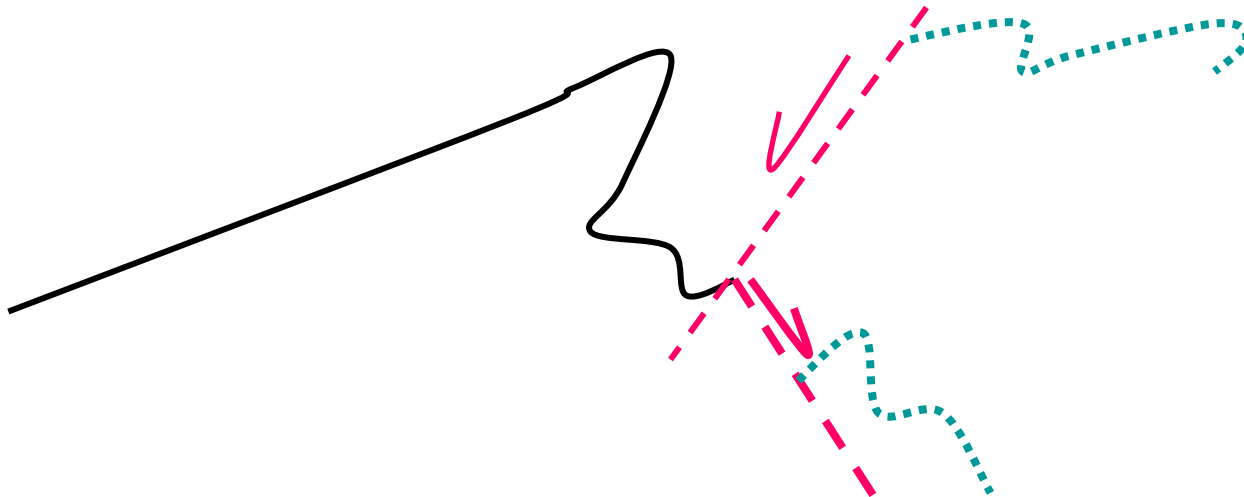
*** Albanian lump chromite on 40% Cr₂ O₃ base, for 2011 year has been sold from 299 -328 \$/ton (www.Ruidow.com)**

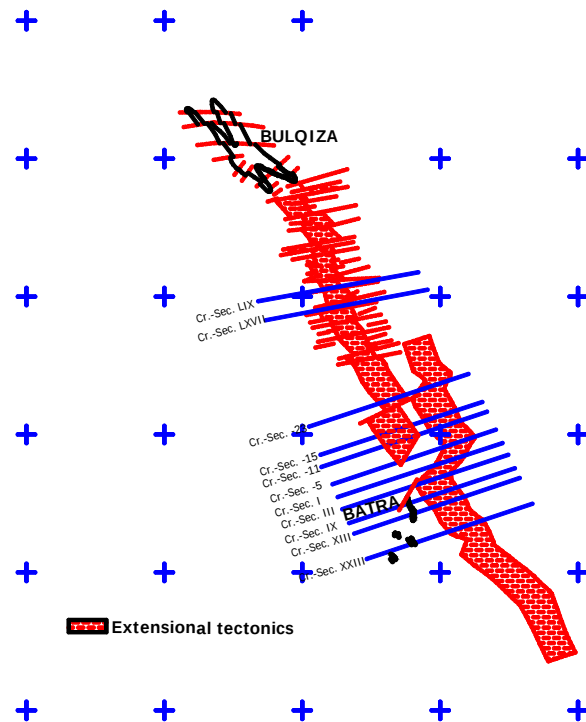
Previous views for East Limb detachment at Bulqiza and Batra deposits

A) Cross-section LI, After Bulqiza geologists, 1986

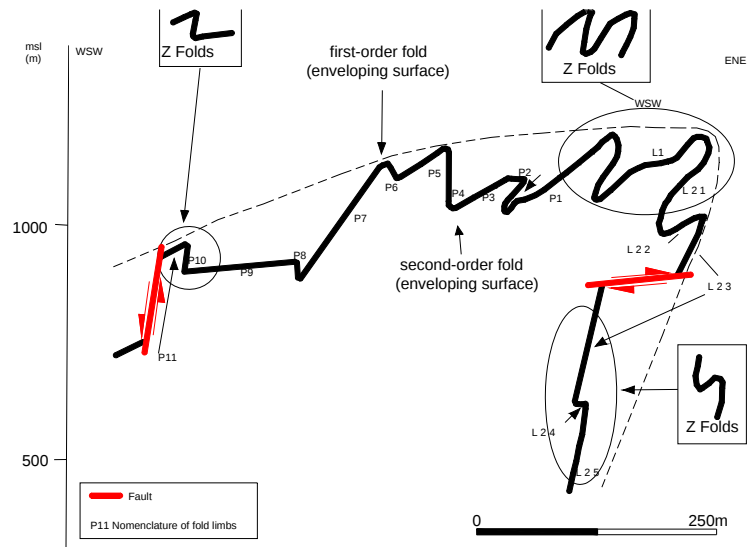


B) Cross-section -11, After Batra geologists, 1986

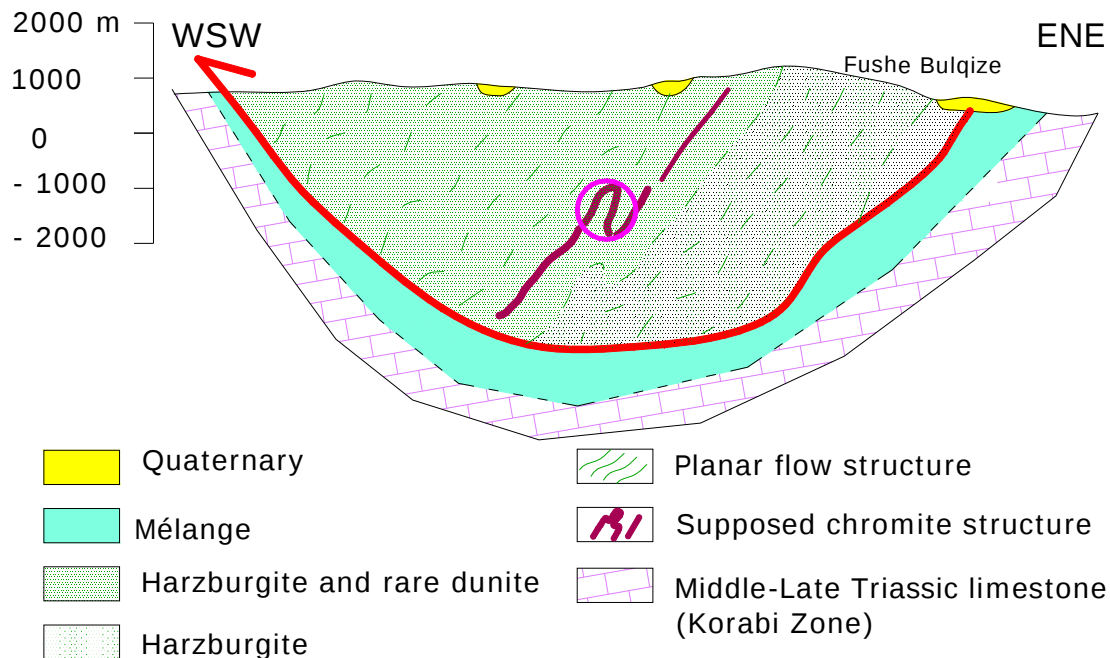




NW-SE extension Bulqiza –Batra deposits, presumed through an extensional tectonics

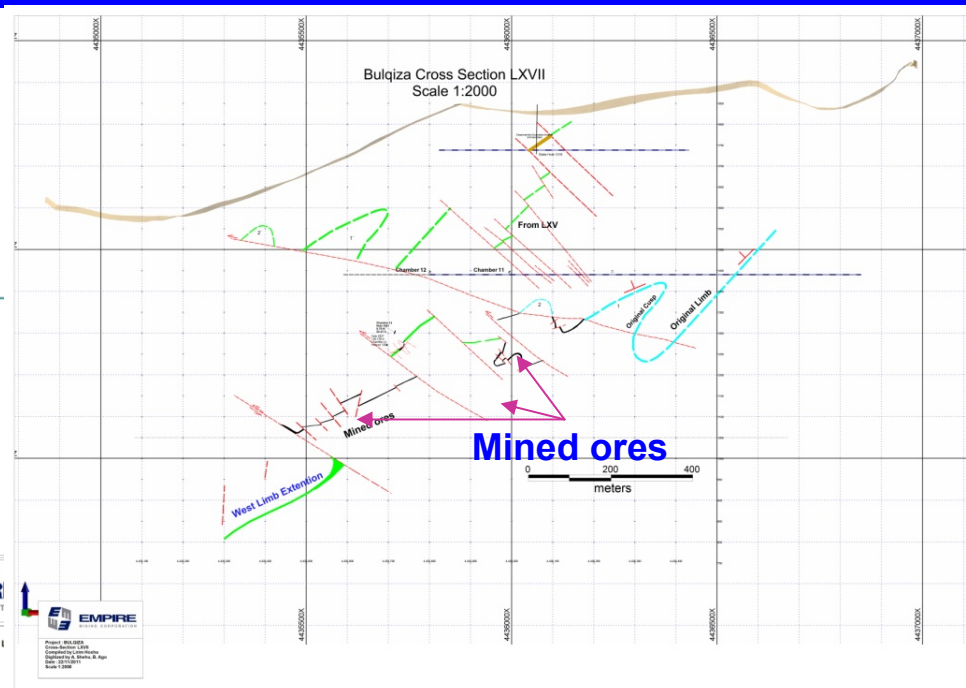
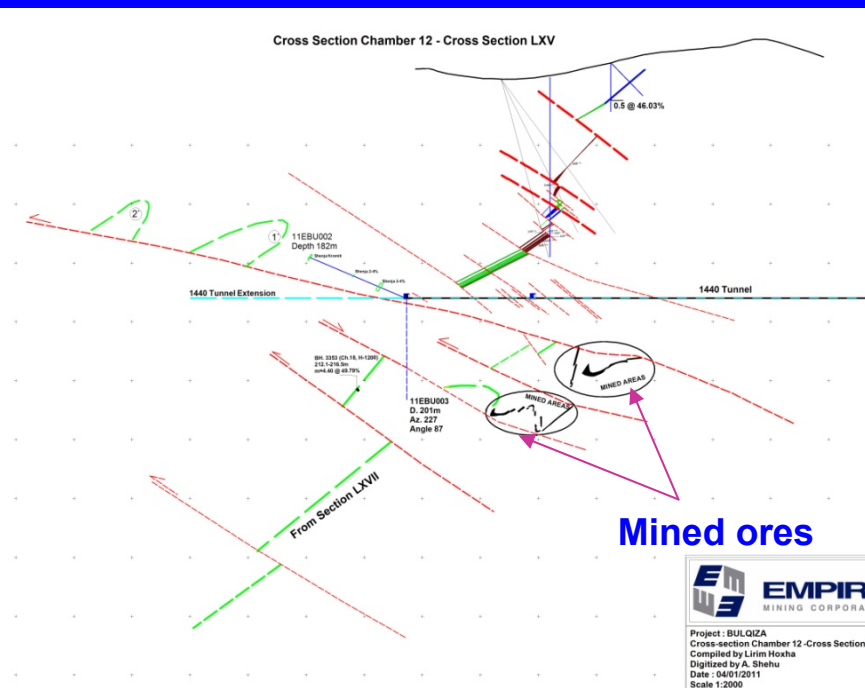


Bulqiza-Batra Mine - The enveloping surface to the second-order folds describes the ENE-vergent anticlinorium of the first-order fold structure with a normal fault in the west and an eastward directed thrust in the east
After Happel et al., ERZMETALL 51 (1998) Nr. 10



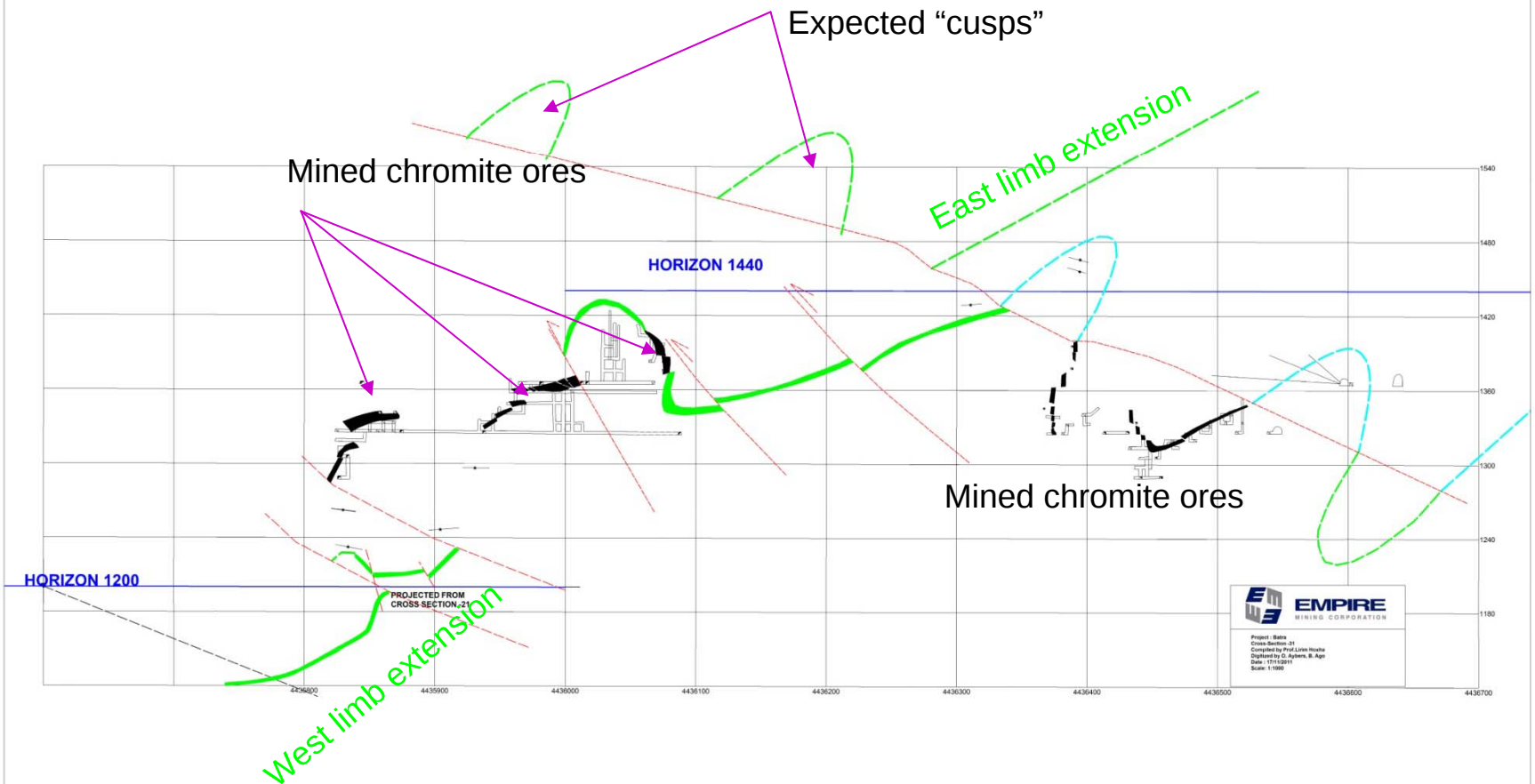
Cross-section C-D New interpretation

Bulqiza ultramafic massif is a homocline structure and the “chromite antiformal” with easterly vergence is a fold in plan of dip and integral part of this homocline—meaning west as well as upward east limb extensions (Hoxha, 2007, updated)

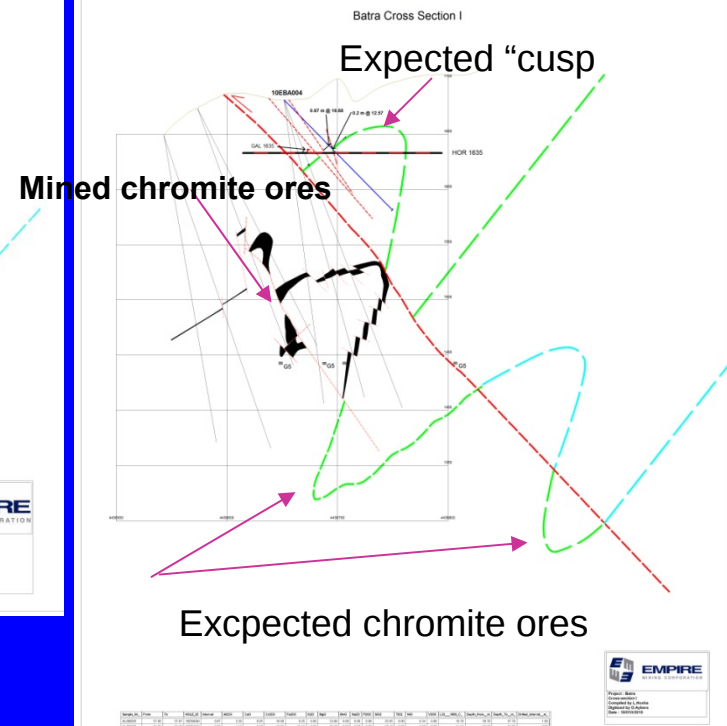
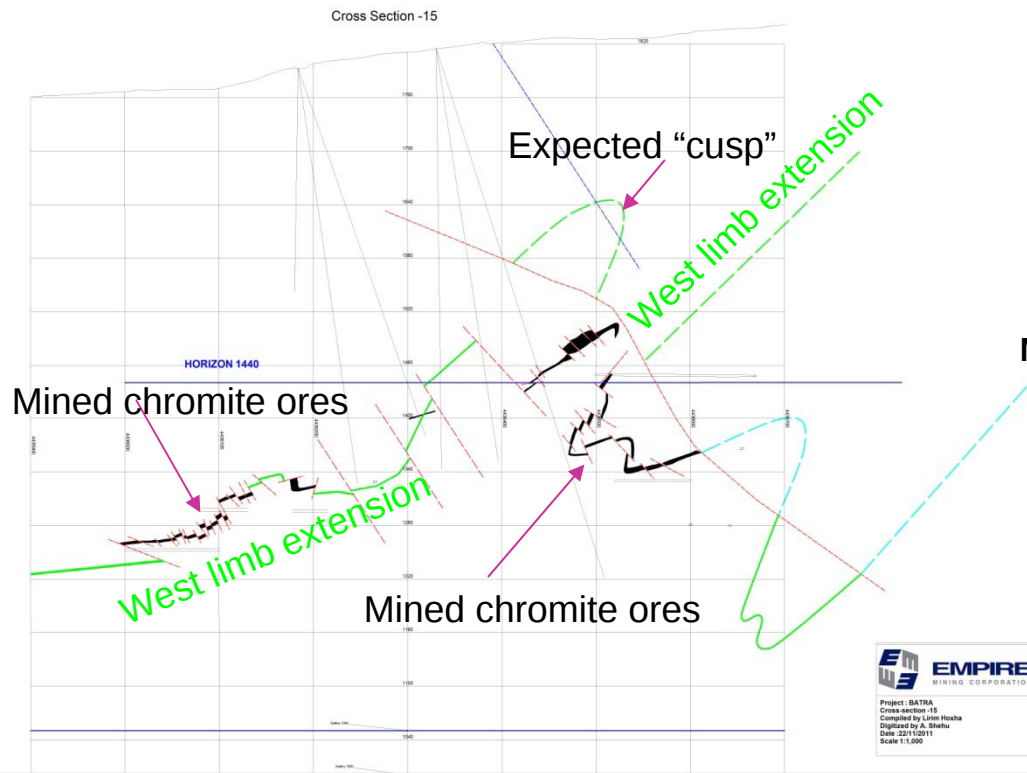


New interpretation of chromite horizon taking into consideration polyphase thrusting tectonics

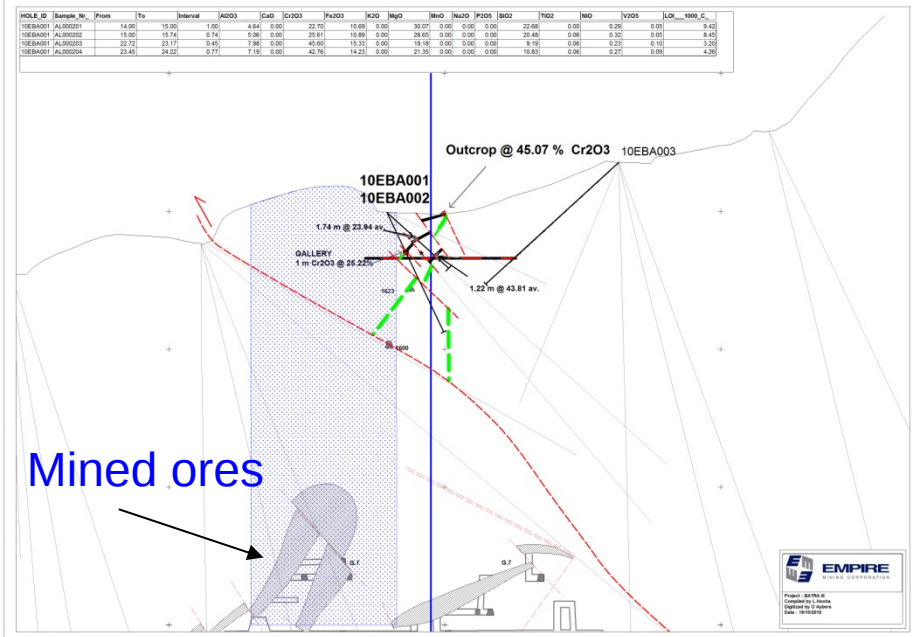
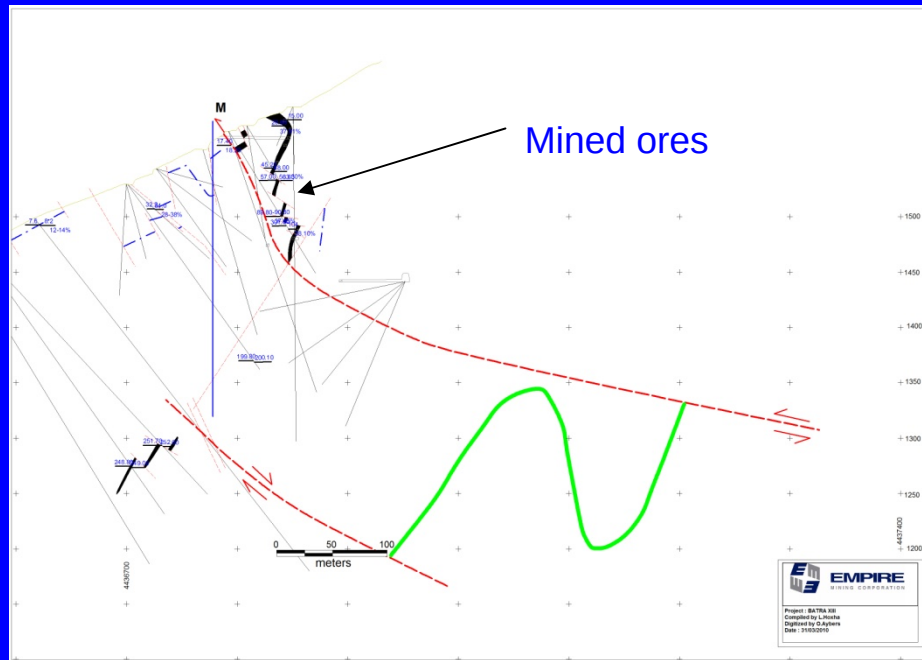
Batra Cross Section -23 Scale 1:1000



Re-interpretation of SE extension Bulqiza-Batra deposits as a fold and thrust chromite horizon affected by westward displaced polyphase thrusting tectonic

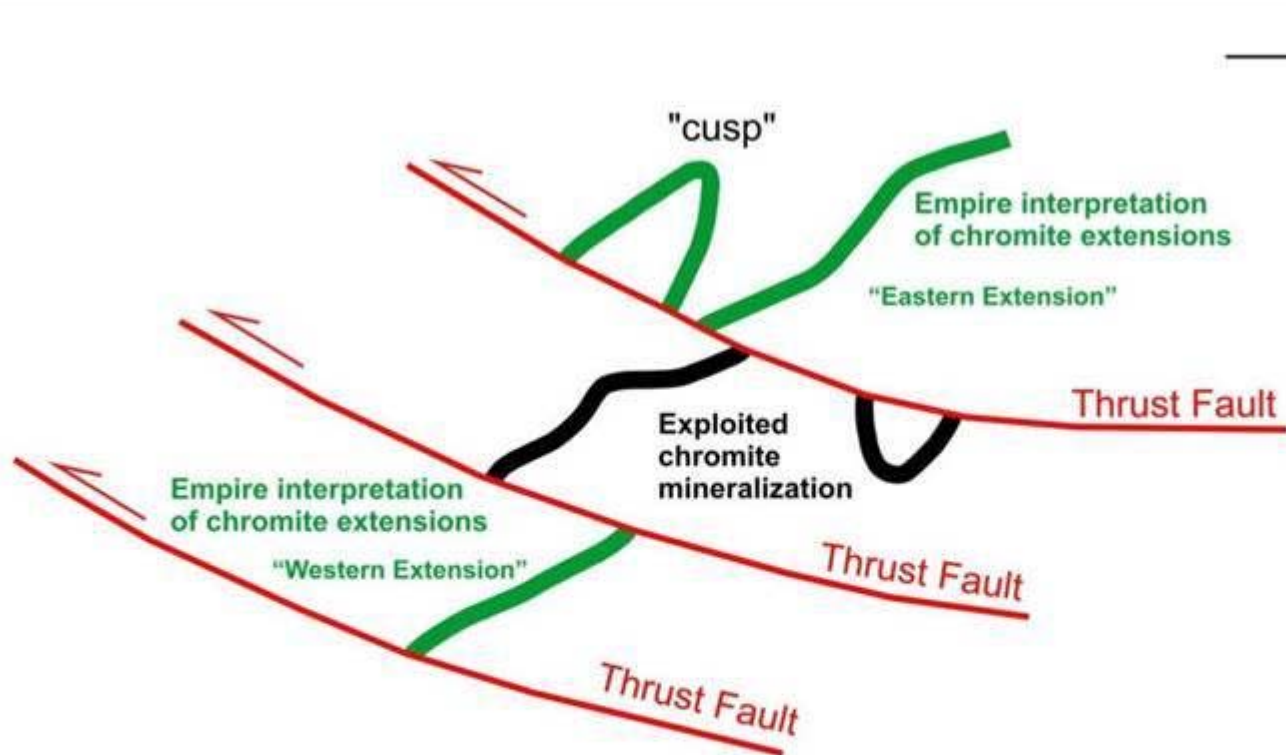


Batra deposit- showing mined chromite ores displaced by polyphase thrusting and possible west limb and east limb extension as well as within mined areas



a)

Batra deposit- new interpretation - Possible exploration of the chromite ores at hanging and the foot walls of the westward displaced thrust



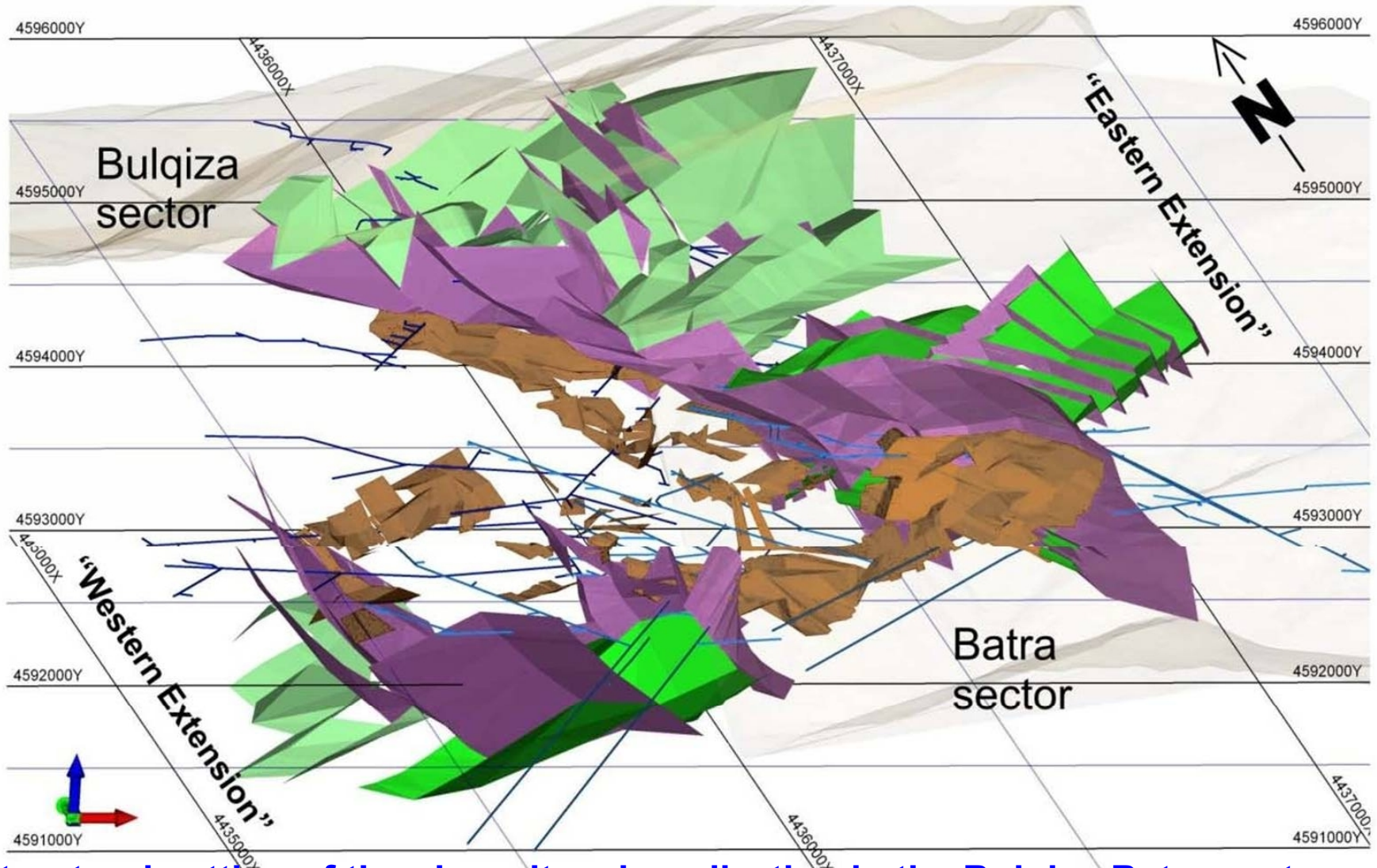
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New interpretation of the structural setting of the chromite mineralization in the Bulqiza-Batra system -secondary fold within west-dipping homocline displaced by thrust faults (after L. Hoxha).



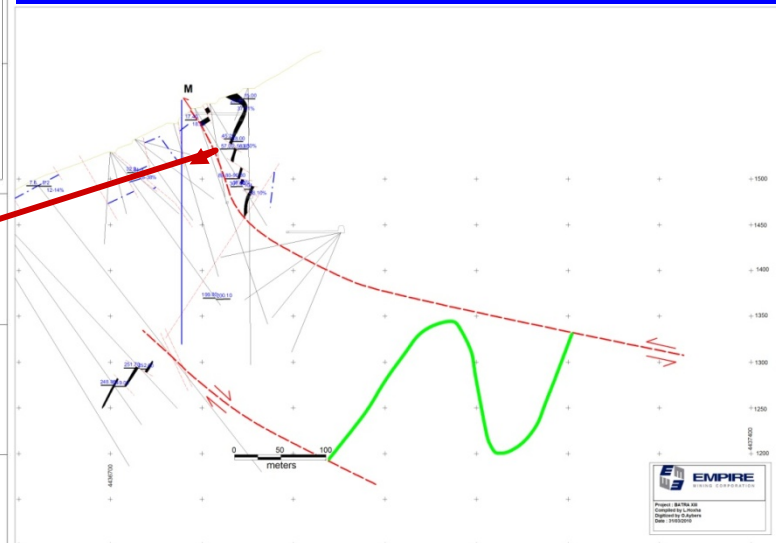
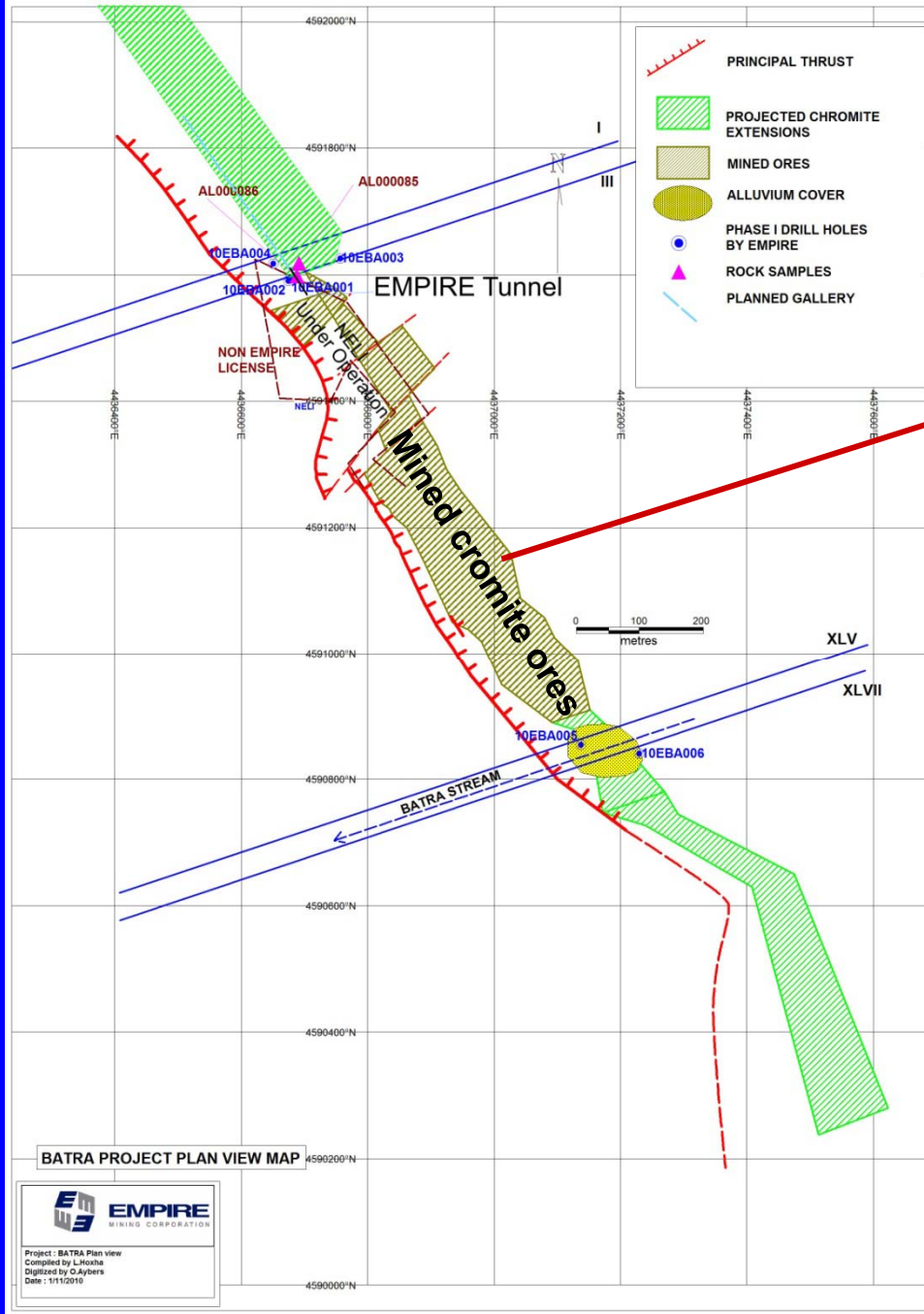
EC TERRA
geology exploration mining

Structural setting of the chromite mineralization in the Bulqiza-Batra system- secondary fold within west-dipping homocline displaced by thrust faults (Hoxha, 2009)



**Structural setting of the chromite mineralization in the Bulqiza-Batra system-
secondary fold within west-dipping homocline displaced by thrust faults**

- Exploited chromite mineralization
- Thrust Fault
- Empire interpretation of chromite extensions



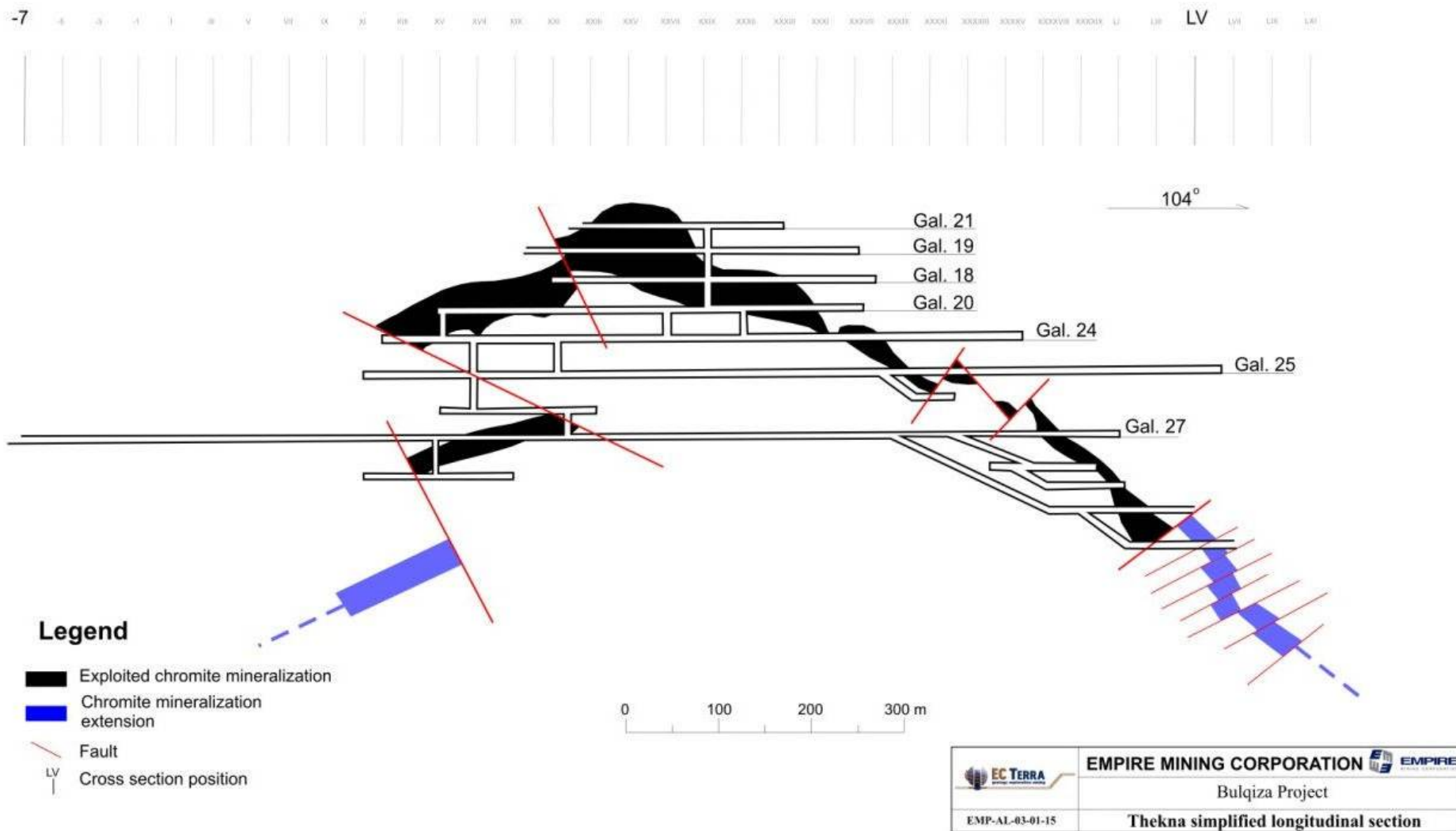
B)

Plan View (A) and) Cross-section (B) showing thrusting chromite ores at Southern Batra

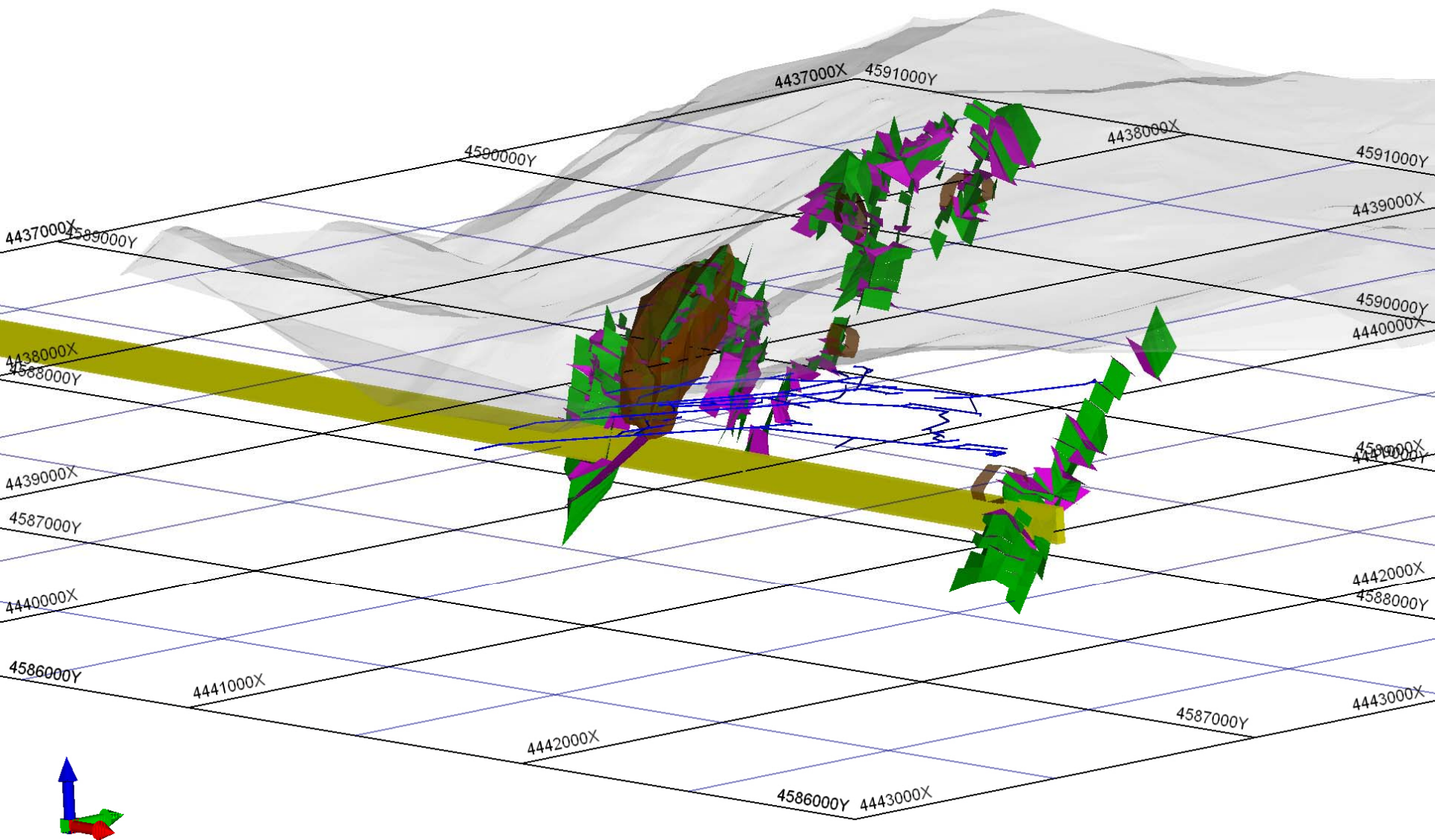
A)



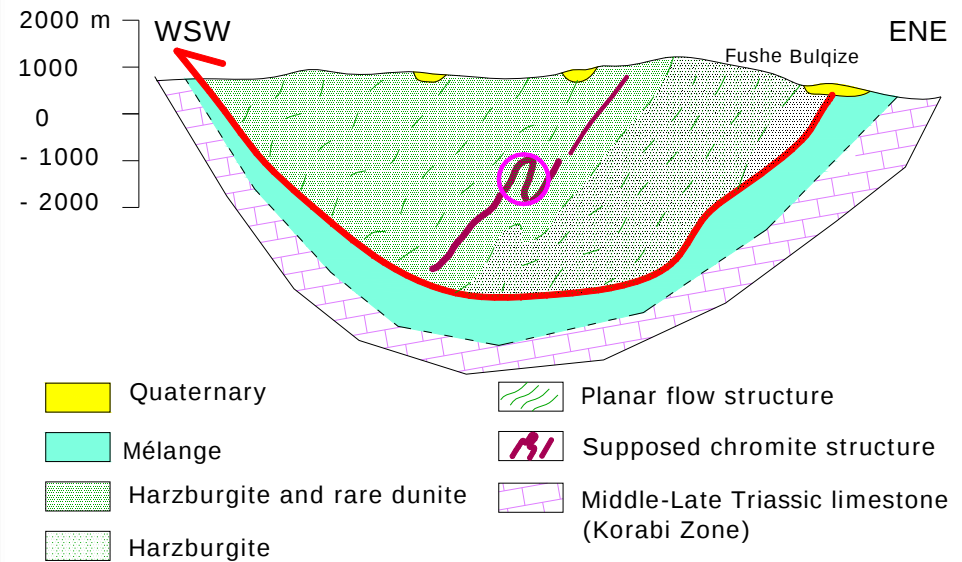
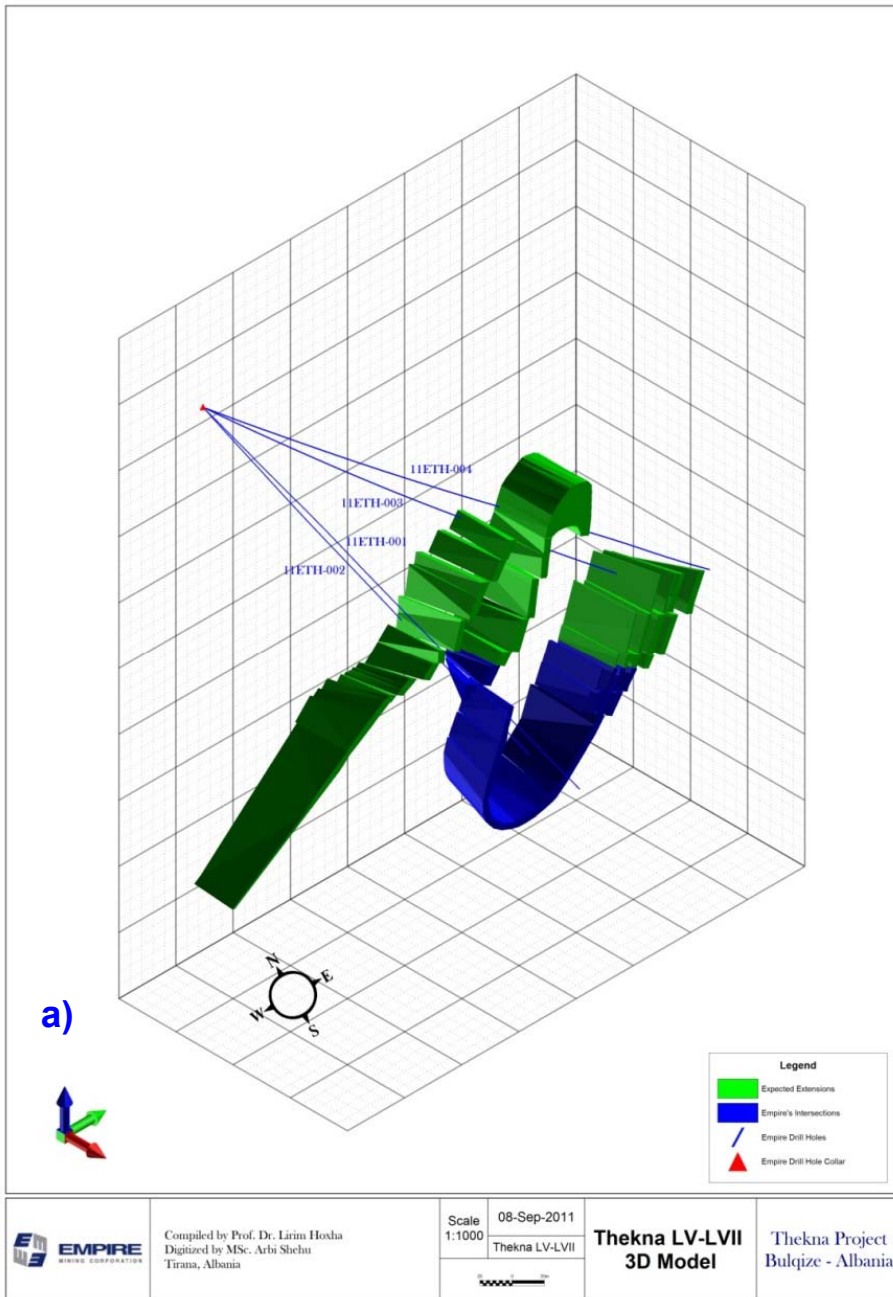
Thrust at Batra chromite deposit



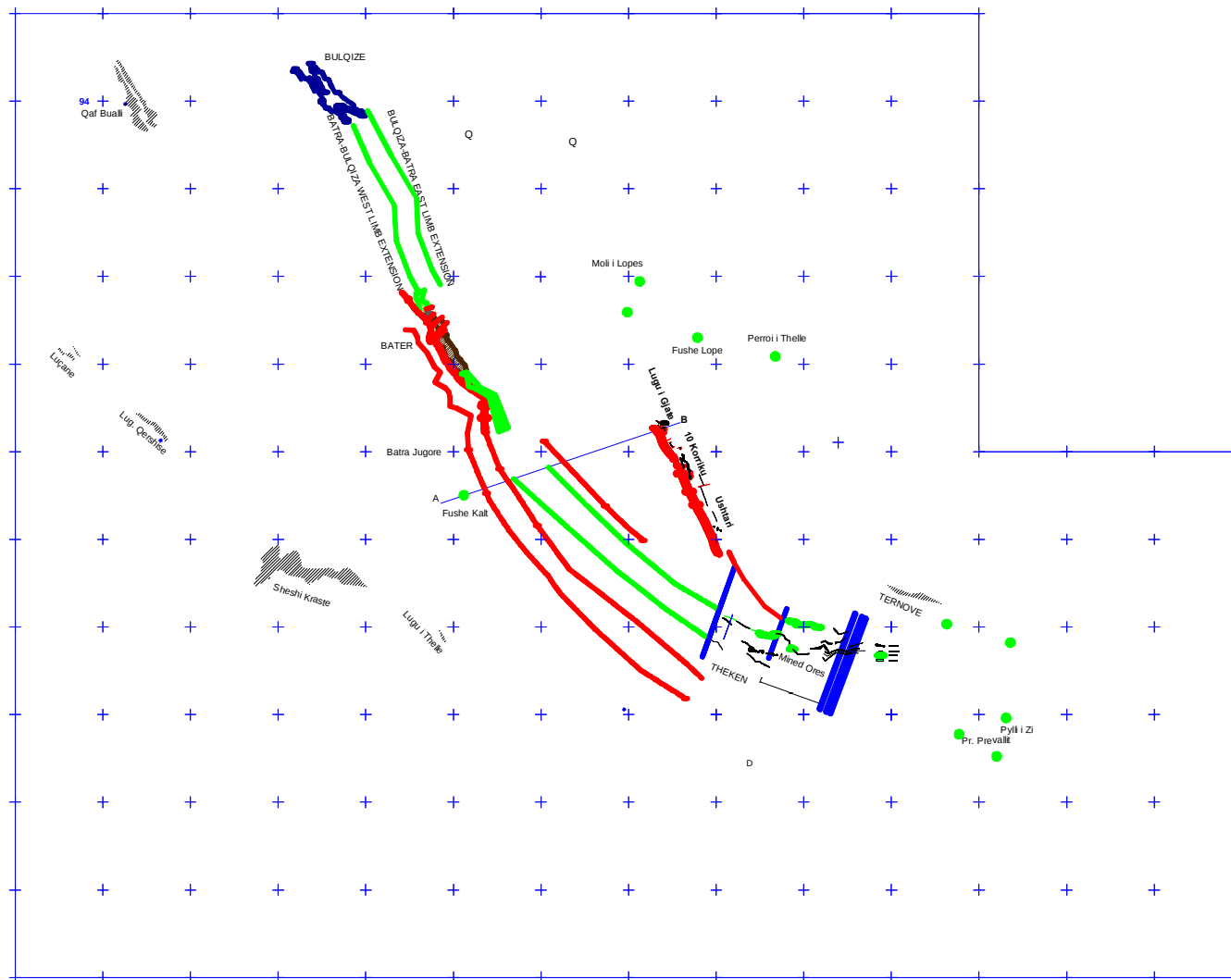
Thekna chromite deposit has been considered as an anticline with NE strike



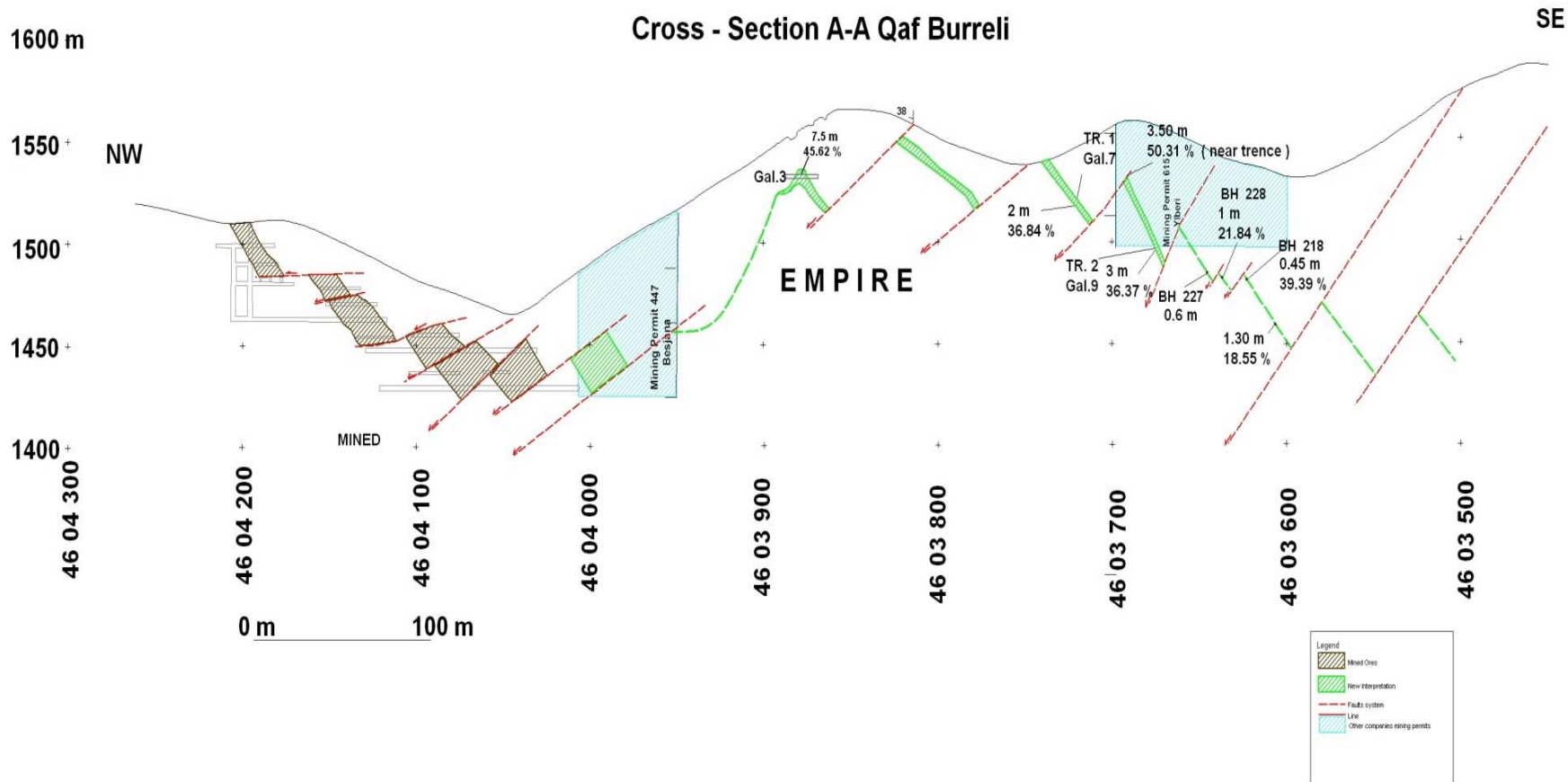
Thekna deposit showing northern and southern Thekna as divided parallel deposits with NW strike (EC Terra, 2009)



Exploration at Thekna chromite deposit (a) proved a fold in plan of dip, integral part of a homocline structure as previously predicted (b)



Bulqiza-Batra-Thekna fold and thrust chromite ore field



NW PART OF BULQIZA MASSIF
SE-NW Polyphase thrusting AT Qafe Burreli chromite deposits

Conclusions

- ★ Principal chromite horizon Bulqiza-Batra-Thekna with easterly vergence folds in plan of dip is integral part of Bulqiza Homocline Ultramafic Massif
- ★ Principal chromite horizon Bulqiza-Batra-Thekna extends all over Bulqiza Ultramafic Massif, comprising a fold and thrust chromite ore field.
- ★ The polyphase thrusting is a result of westward displacement of Bulqiza Ultramafic Massif
- ★ Exploration works performed by Empire Mining Corporation at Bulqiza-Batra-Thekna ore field and NW at Qafe Burreli indicate for high developed west directed polyphase thrusting tectonics that led to new interpretation of the structural setting and extension of the chromite mineralization potential.
- ★ Especially, southern part of the fold and thrust chromite ore field: Bulqiza-Batra-Thekna, represent very high potential for exploration of new chromite ores analogues in amount and grade with mined ones.

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