Magmatic Ore Deposits:

A number of processes that occur during cooling and crystallization of magmatic bodies can lead to the separation and concentration of minerals.

1- Pegmatites

2- Layered intrusions

3- Kimberlites

Examples of Magmatic ore deposits:

1- Chromite deposits

2- Nickel – Copper deposits

3- Platinum group metal (PGM) deposits

- **1- chromium ore deposits**

Ores of chromium (Cr) and of the platinum group elements (PGE) are almost exclusively found associated with basic and ultrabasic plutonic igneous rocks (they are part of a family of metals referred to as “orthomagmatic” ores):

- The metals are derived from the magmas themselves, and the magmas are derived from partial melting of peridotitic upper mantle.
- Relative to their source magmas, Cr & PGE are enriched by a factor of ~1000.
- The vast majority of Cr extracted from magmatic ores comes from mines in SouthAfrica (Bushveld layered intrusion

- ***Origin of chromite deposits:***
- All chromite deposits are believed to have formed by early crystal settling or by late gravitative liquid accumulation. These processes aid in understanding how layered deposits form, but where differential pressures exist, liquid injection is more likely to form podiform deposits.

- ***Kind of deposits***
- Almost all chromite deposits are magmatic segregation in ultrabasic rocks. Chromite occurs in the host rock as masses, lenses, and dissemination.
- All economic deposits of chromite are in ultrabasic rocks and are either stratiform in layered intrusions (98% of world's chromite resources) or podiform
- in peridotite masses or dismembered ophiolites:

Main types of chromite deposits

A- Stratiform chromite deposits:

Consist of laterally persist chromite rich layer a few (mm) to several (m) thick alternating with silicate layer (Fig 1, A, B).

- The silicate layer include ultramafic and mafic rock such as dunite, peridotite, pyroxenite and variety of others, less commonly gabbroic rocks they are generally found within basal portions of mafic – ultramafic layered intrusions of Archean age such as the Bushveld igneous complex in south Africa and Canadian stratiform chromite deposits. The (average Cr_2O_3 = 10.7 %)

- Each chromite band occupies a stratigraphic position the layer are not deformed composed of small euhedral chromite crystals and do not exhibited nodular or orbicular texture.

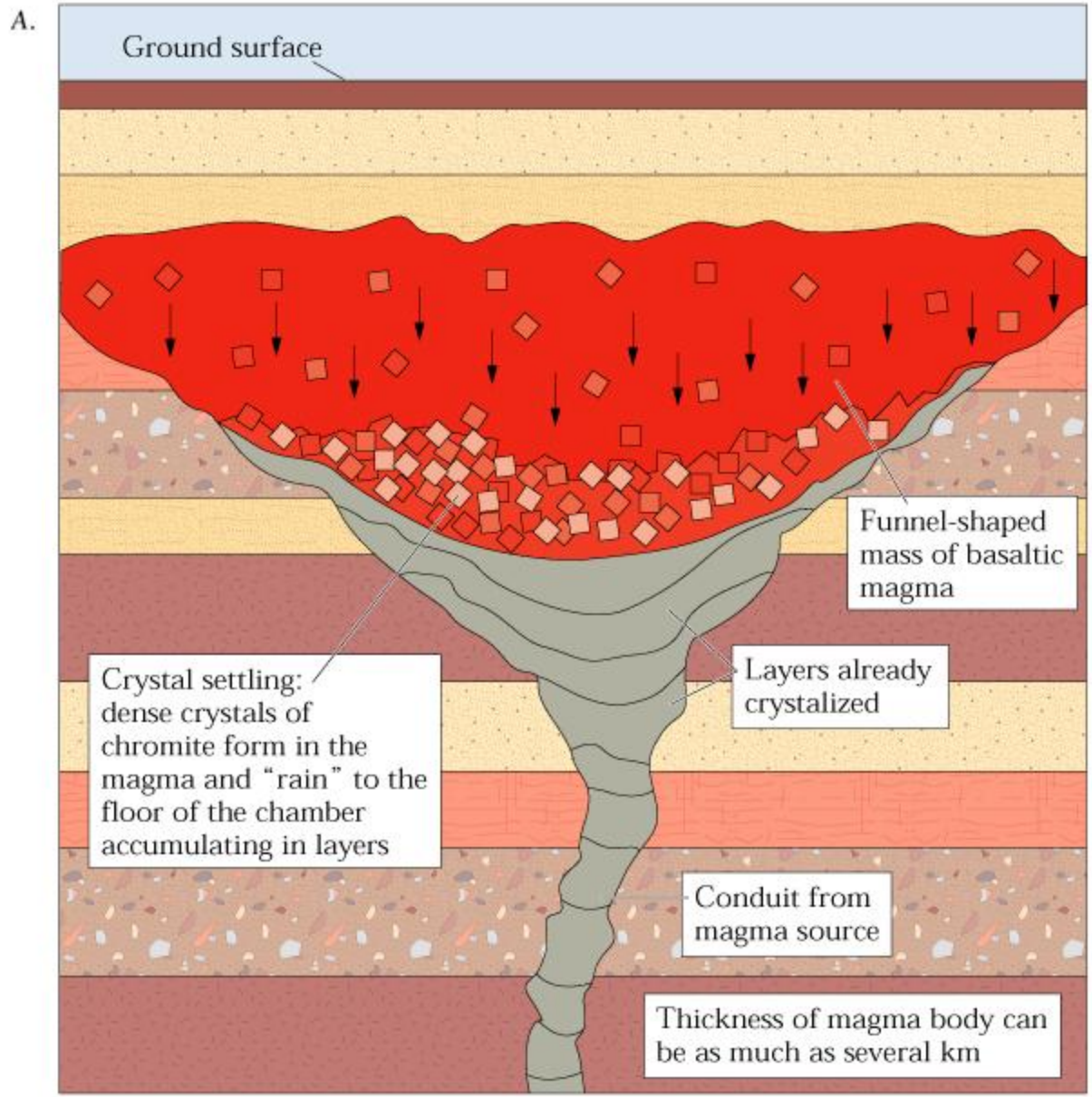
A

B

Fig. 1 **A** Bushveld chromitite hand sample, **B** plutonic rock bodies of basaltic composition with stratiform chromite that are layered or banded.

Formation of stratiform chromite

Chromite, the main ore mineral of chromium, crystallizes from a magma and, because it is denser than the magma, sinks to the bottom and accumulates in a process called crystal settling.



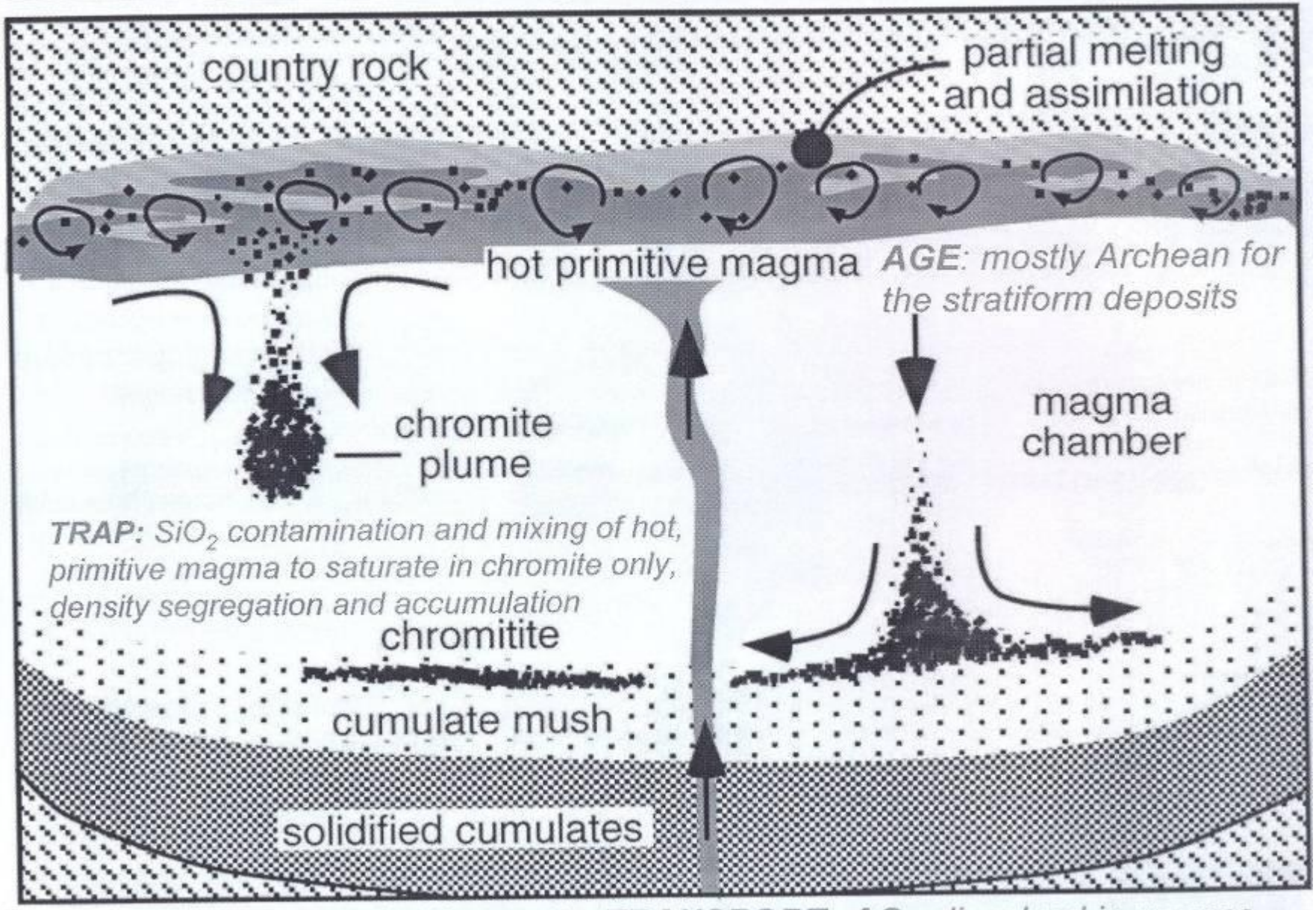
B- Podiform chromite deposits:

- Consist of pod to pencil-like, irregularly shaped massive chromite bodies and they are predominantly found within dunitic (olivine-rich) portions of Ophiolite Complexes.

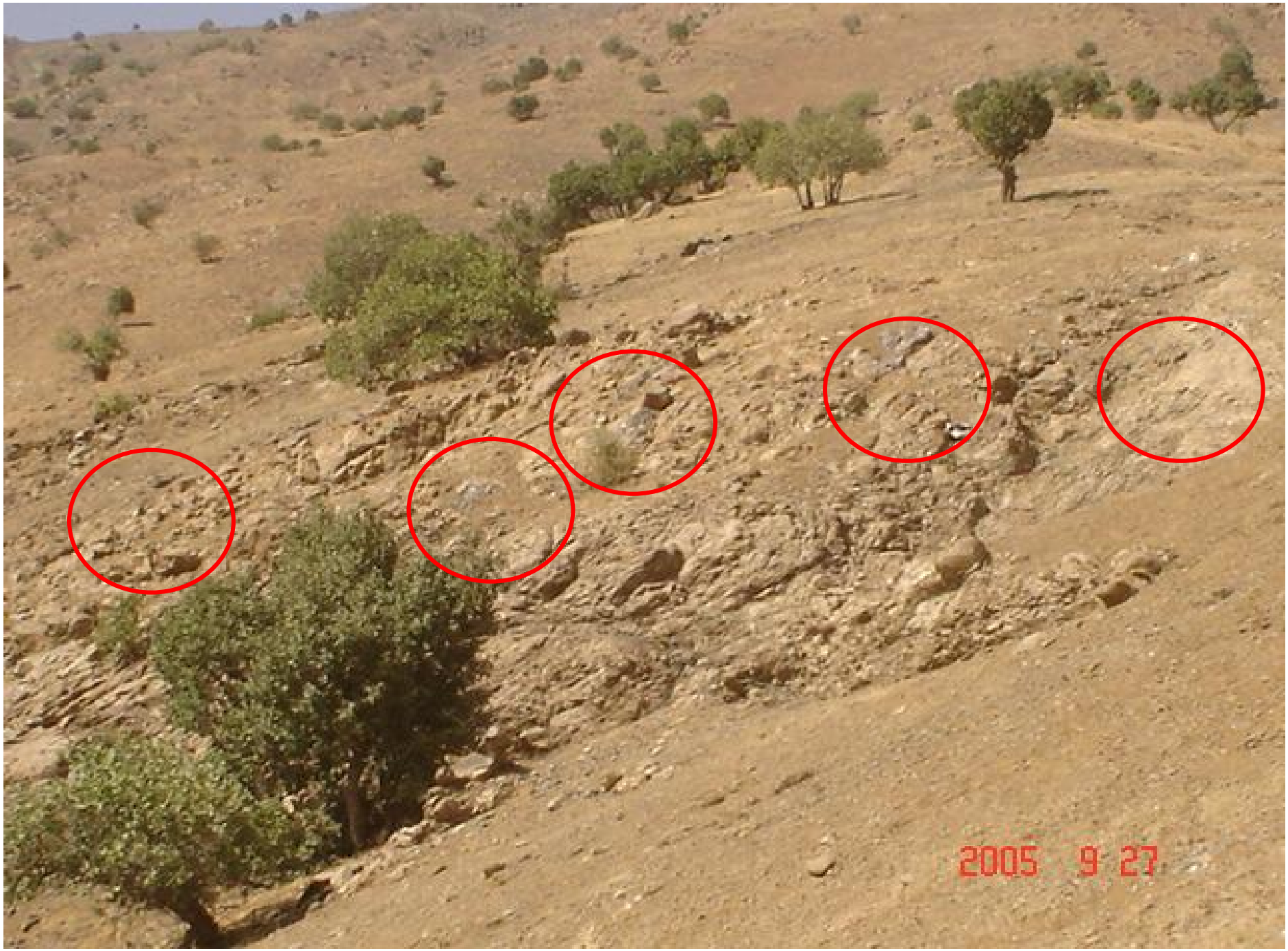
- The rock associated with podiform chromite is generally referred to as Alpine-type peridotites and they are usually found along major fault zones within mountain belt.
- The chromite may exhibit nodular texture and show deformation structure such as pull- apart textures.

- Crystal grains are generally variable in size

Contamination & Mixing Origin of Massive Chromitite



SOURCE of Cr: peridotitic mantle; **TRANSPORT** of Cr: dissolved in magma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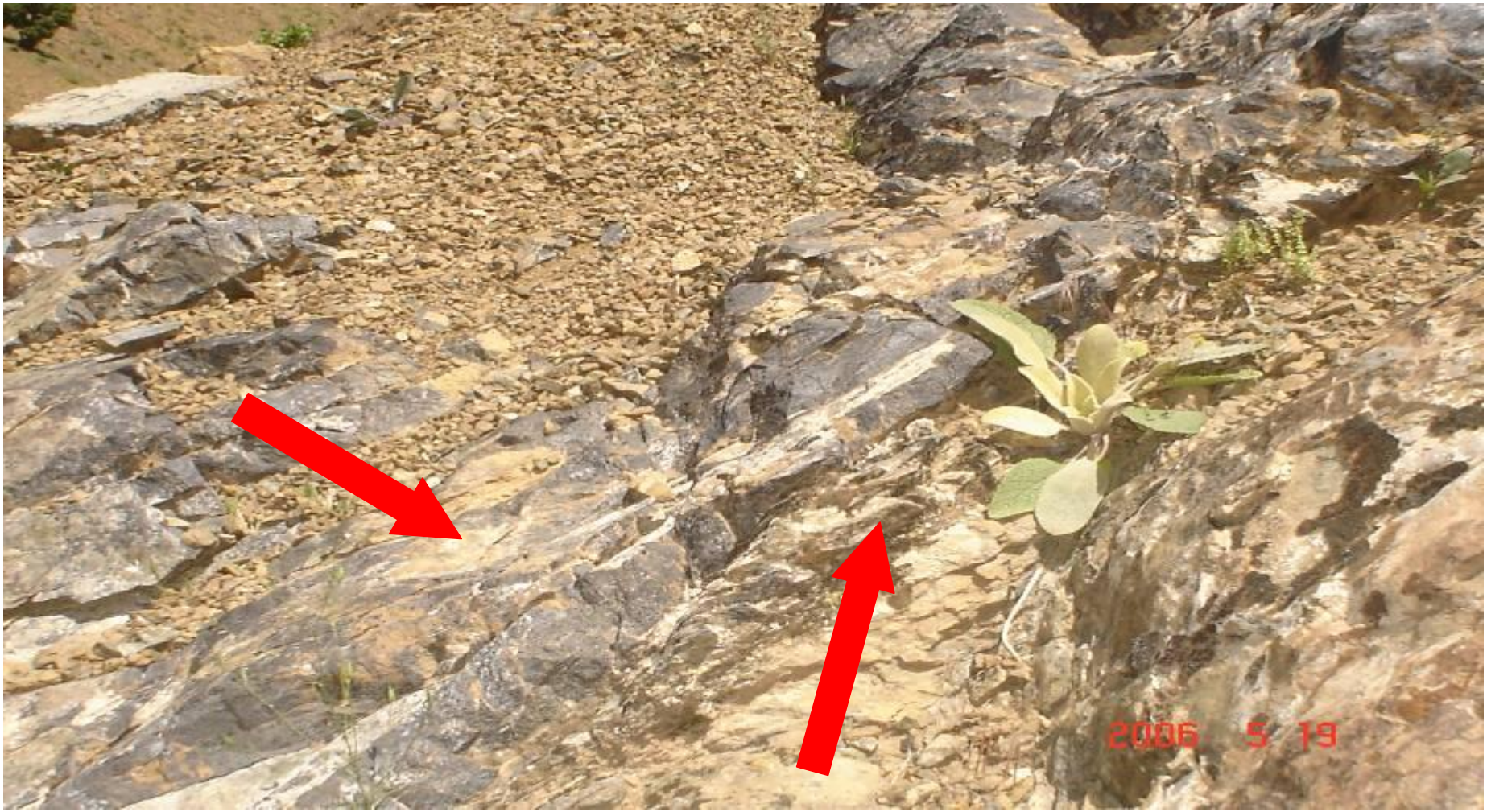


Chromite pods envelops by dunite and separated from the adjacent pot by harzburgite

Properties of Chromite

- **Formula:**

(Fe,Mg)(Cr,Al)2O4

- **Density: 5.1 g/cm3**
- **Hand Specimen:**

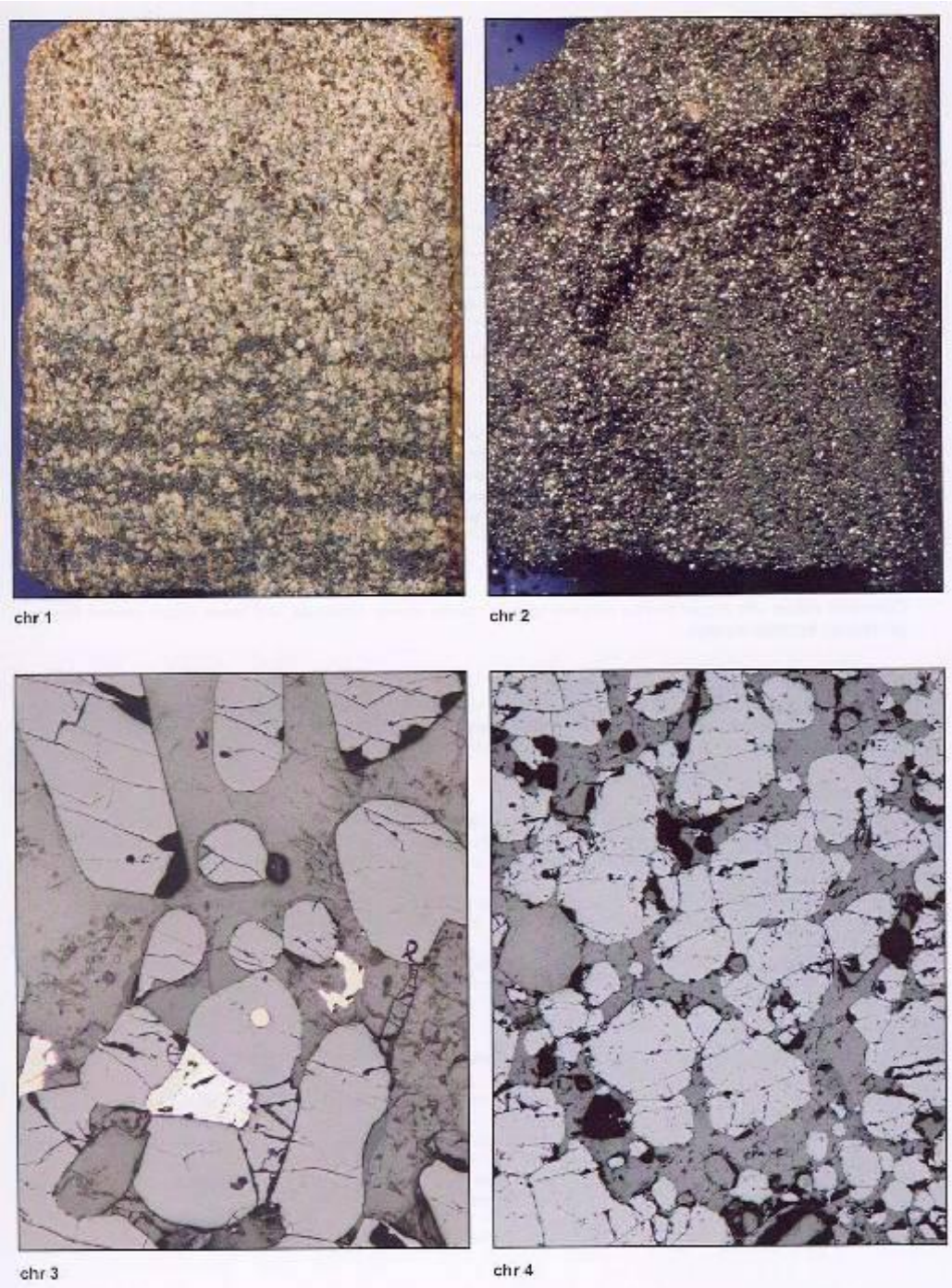
Iron black to brownish black in colour; sub-metallic lustre; weakly magnetic

- **Polished Section:**

Dark grey to brownish grey in colour; low reflectance; isotropic
Typically euhedral grains when separated by silicate minerals; equigranular when massive

- **Chromitite = massive**

accumulation of chromite



Structure classification of chromite pods:

1- Concordant deposits:

This type makes up about 50 percent of the chromite occurrences

1- Most are tabular in shape but rarely may they have a pencil form.

2- When such a deposits consist of several sheets, these sheet or plate have a dunite wall and are always from each other by harzburgite

3- Three type deposits contain massive, disseminated and antinodular ores; massive ore have always pull-apart textures.

4- The ore lenses and its internal foliation and lineation are parallel to those in the host rock peridotite

5- Such ore bodies have internal structure make angle of 20 with dunite wall and surrounding peridotite.

2- Sub concordant deposits:

This type makes up about 25 % of the chromite occurrences.

1- Such ore bodies have internal structure make angle of 20 with dunite wall and surrounding peridotite
2- Lineation within the ore can be follow local change in the dip of ore sheet.
3- These deposits are typically tabular in form.

4- Ores are much less deformed and pull a part texture in the massive ore are rarely and poorly exposed.

5- They are characterized by very large olivine grains and often contain large equine chromite crystal > 1 cm.

6- A zone rich in dunite patches appears to run either slightly or strongly oblique to harzburgite

3- Discordant deposits:

1- This type deposit of chromite represents about 25 % of chromite occurrences

2- The main feature of this class of deposits may be summarized as follows;

3- Structure in the rocks immediately surrounding the deposit is disturbed with respect to their regional latitude.

4- Lineation in the ore is not always present because the ore is sometimes only slightly deformed.

5- Lineation in the surrounding peridotite give the general direction of extension of the ore body.

6- This type have also massive, disseminated, antinodular, and banded ores, the last type show sedimentary feature such as slump and cross bedding.

Exploration (prospecting) Guidelines of chromite deposits.

- Stratiform chromite deposits:

1- Identify well layered mafic – ultramafic intrusions.

2- Prospect below the mafic cumulate portions of intrusions (below the portion which is completely gabbroic).

- Podiform chromite deposits:

a- Carefully prospect within all dunitic portion of Alpine- type peridotite (Harzburgite -dunite component of Ophiolite Complexes).

- ***Mineralogy, Tenor, and Treatment***

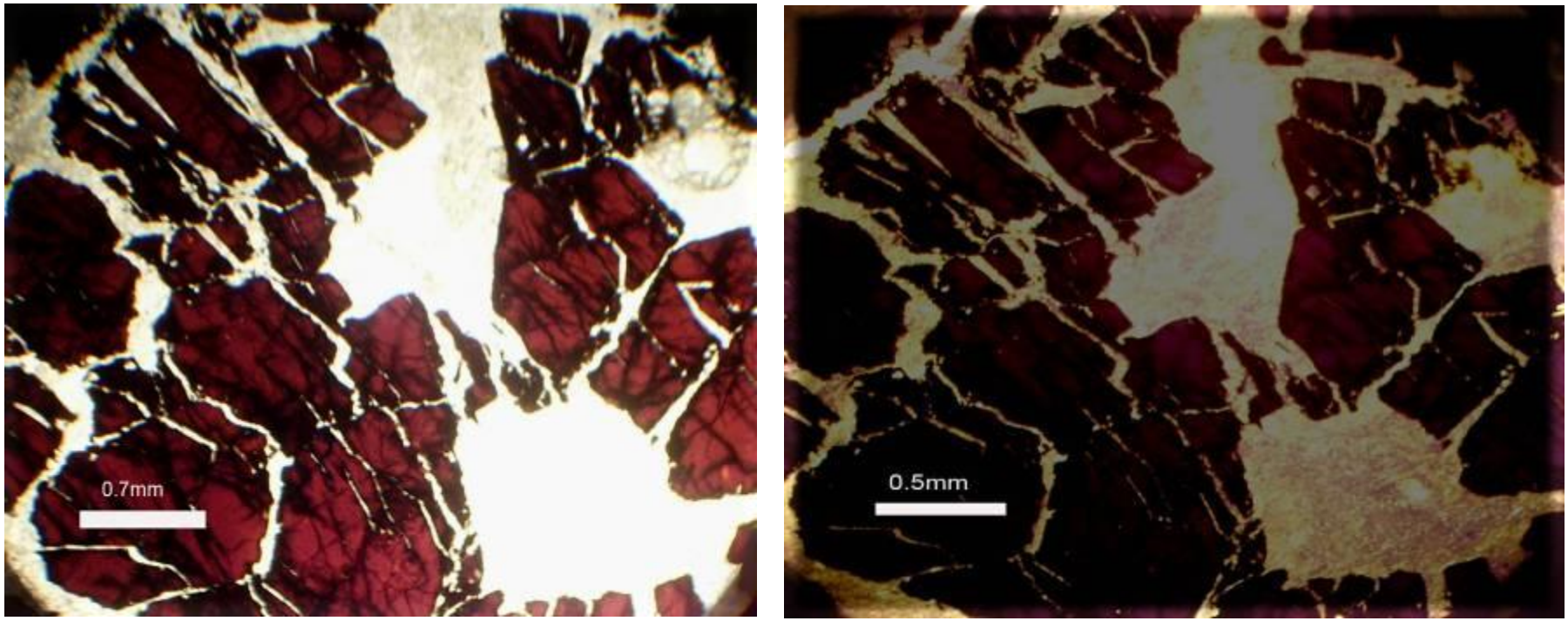
- ***Mineralogy, and Tenor***
- There is only one mineral, chromite, that theoretically carries 68 % Cr_2O_3 and 32 % FeO, but Al_2O_3, Fe_2O_3, MgO, CaO and SiO_2 may displace some Cr_2O_3, reducing the Cr_2O_3 content to as little as 40 % Chromite chemically varies within wide limits permitted by formula (Mg, Fe^{+2}) $(Cr, Al, Fe^{+3})_2$ O_4. Commercial ores should contain 45 % Cr_2O_3. The chrome-iron ratio should be above 2.5:1 for metallurgical chrome.

- ***Treatments:***

- Chromite is marked as lump chromite after hand sorting or rough concentration. Most chromite ores are not adaptable to concentration processes.
- The chrome ore is smelted in an electric furnace with fluxes and carbon to ferrochrome, in which form most of its marked.

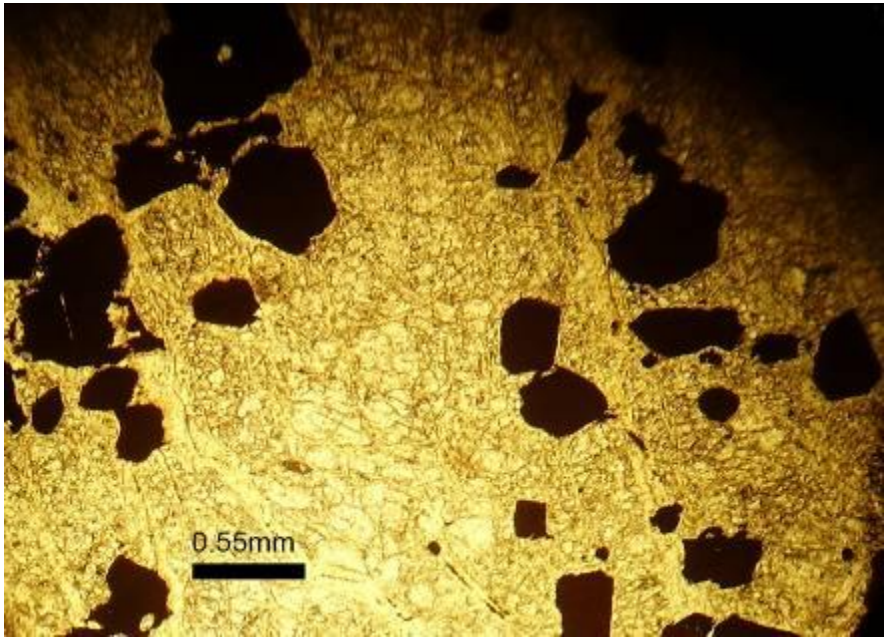
- ***Uses:***

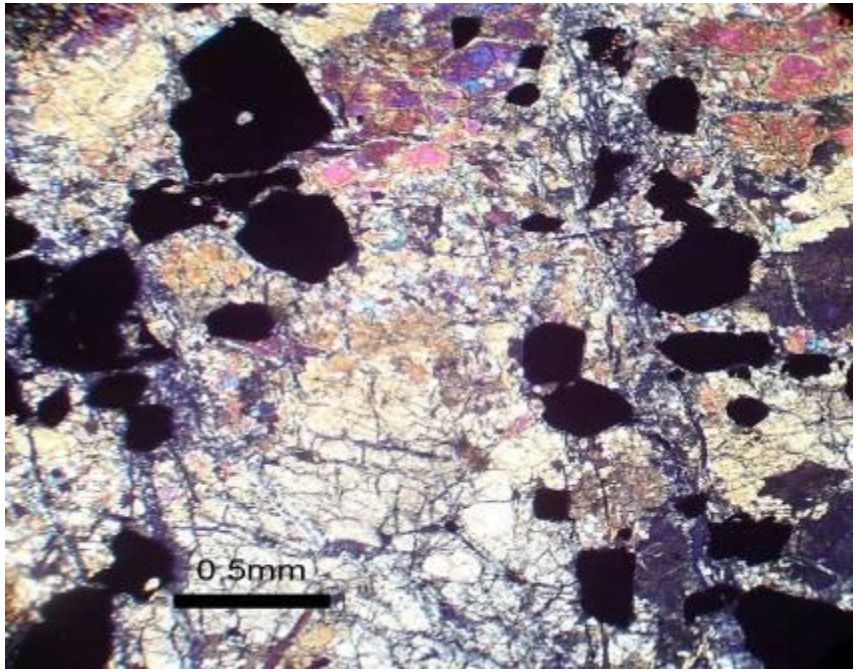
- The main uses for chromium are: metallurgical, 67%; refractories, 18 %; and chemical, 15 %. The metallurgical uses include a great variety of alloys, mainly with iron, nickel, and cobalt.
- Chromium impart to alloys strength, toughness, hardness, and resistance to oxidation, corrosion, abrasion, chemical attack, electrical conductivity and high temperature breakdown.
- The great strength of chrome steels allows a reduction in the weight of metal in automobile, airplane and trains. The stainless steels containing 18% Cr and 8 % Ni.



A B

Brecciated chromitite rocks, the chromite grain transected by many cracks. (A: under PPL, B: XP).

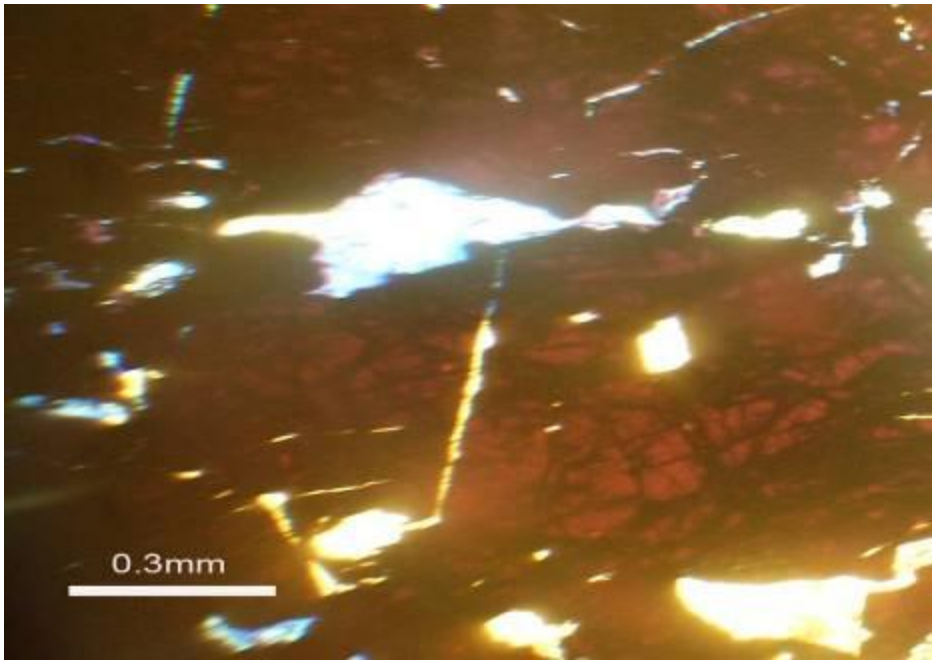


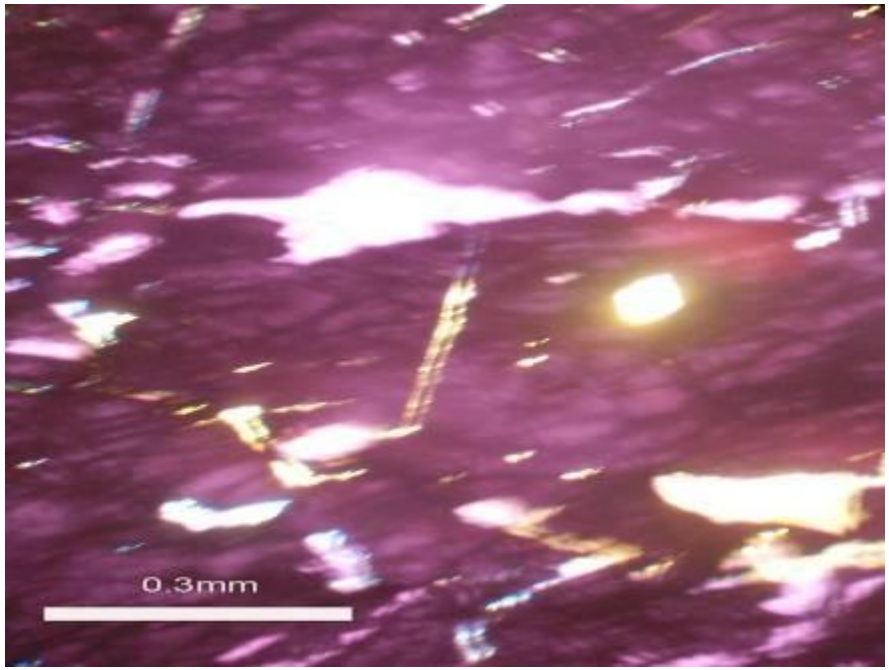


A

B

Disseminated subhedral to anhedral chromite crystal in a matrix of olivine in north of Kuradawi village (A: under PPL, B: XP).





A B

Anhedral crystals of chromite showing pull-a part texture and most of chromite grains exhibit thin rims of ferritchromite, the white interstitial represents the matrix. (A: under PPL. B: under XP).