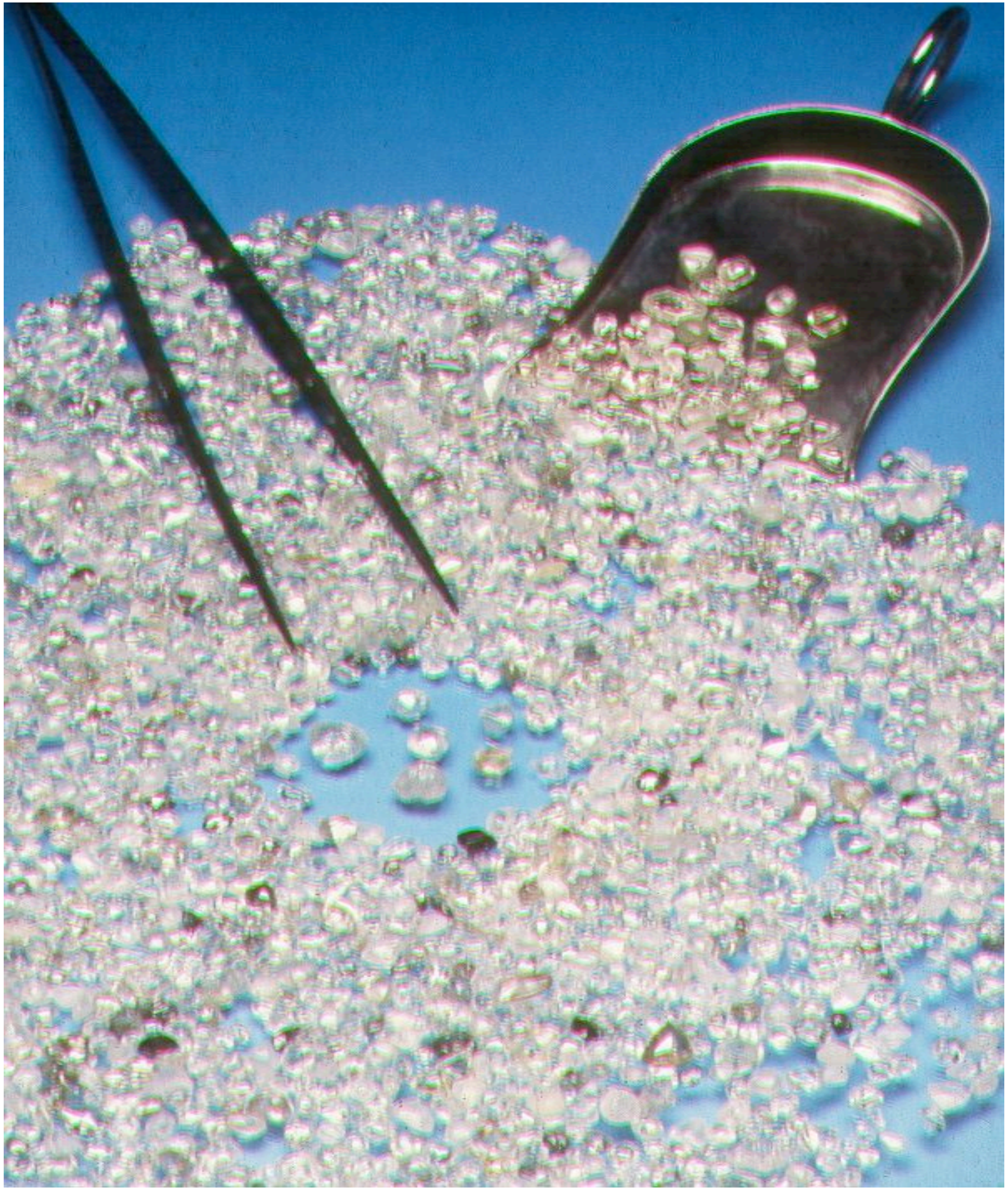

Magnetic signatures of Diamonds

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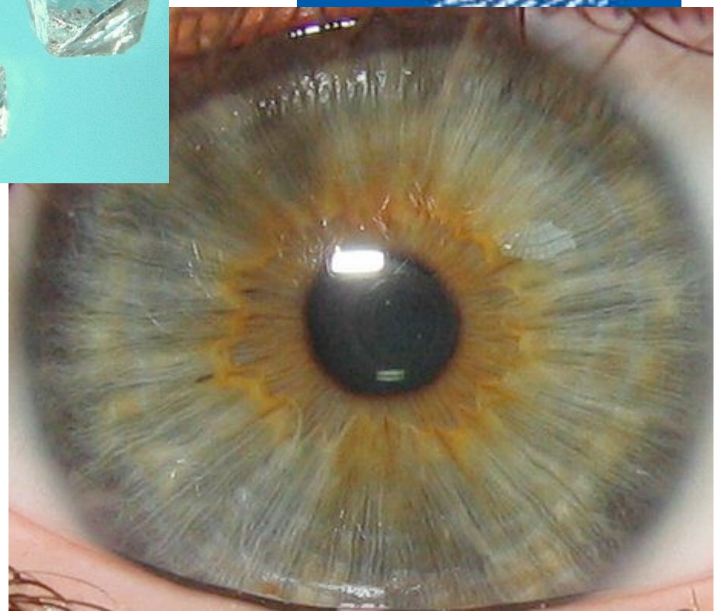
On December 1, 2000 the UN General Assembly unanimously adopted a resolution defining the role of conflict diamonds (also known as *blood* diamonds) with the intent of breaking the link between the illicit transaction of rough diamonds and armed conflict.

In May 2000, the diamond producing/trading industry established the Kimberley Process Certification Scheme (KPCS) to stem the trade of conflict diamonds.

But how to identify a diamond nondestructively?

Like a fingerprint or iris scan, we are developing techniques to unambiguously identify the unique magneto-genetic code of diamonds based on the minute inclusions within them.



Blood diamonds: Can they be characterized magnetically?

- Diamond geochemistry is relatively well known, and unfortunately the bulk or trace element compositions of diamonds are of little value to reveal their origin. Geochemical methods are largely destructive, thus obliterating the diamond sample.

- To potentially learn something about the genesis of diamonds, a technique must be sought that is non-destructive and can yield information concerning their strain state and inclusion geometry. Magnetism holds much promise in these respects knowing that a small proportion of the inclusions are magnetic phases such as iron sulfides.

- We study the magnetic signatures of individual diamonds in two principal ways: (1) to characterize their low temperature (down to liquid helium, or 4 K) behavior and (2) to measure their magnetic anisotropy. A well-known example of the former is the Verwey transition in magnetite that occurs at around 120 K.

- Even a few nanometer-sized grains produce enough signal to be measurable.

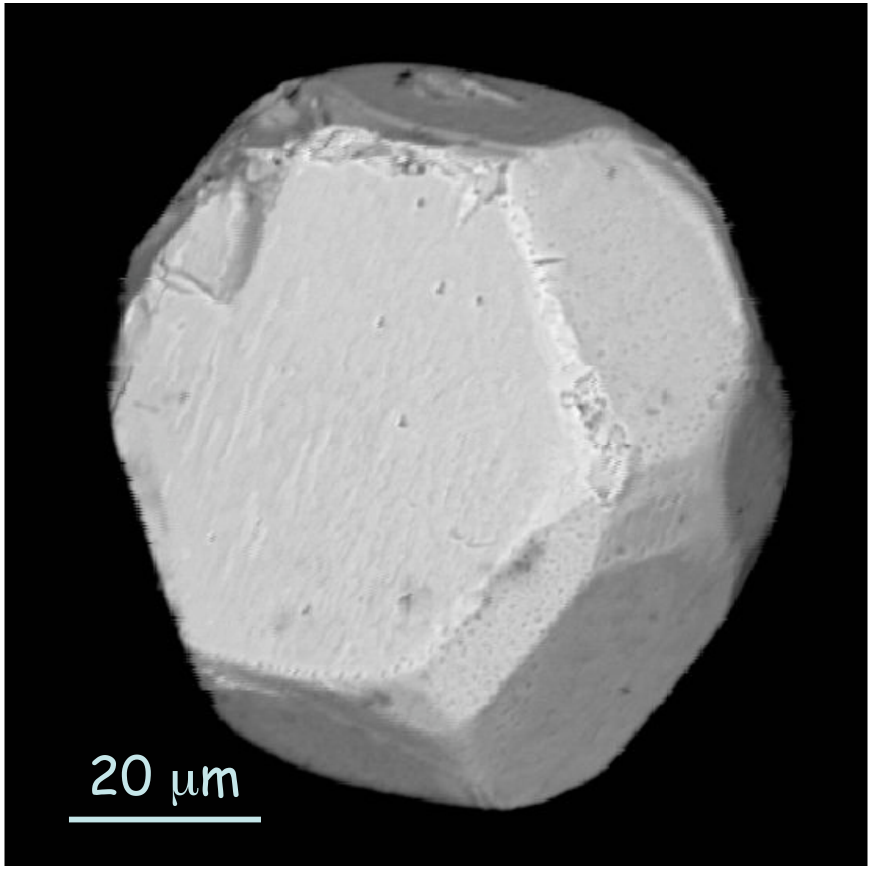
- Solid inclusions are virtually never spherical in diamonds. This means that the solid inclusions inherently have a shape anisotropy.

- A quick and non-invasive way to quantify the geometrical alignment of an assemblage of magnetic inclusions is to study the magnetic anisotropy of the diamonds.

3.2 Ga peridotitic silicate inclusions in diamond, (De Beers and Finch)

From:S Richardson,UCT

Eclogitic sulfide inclusions in diamond

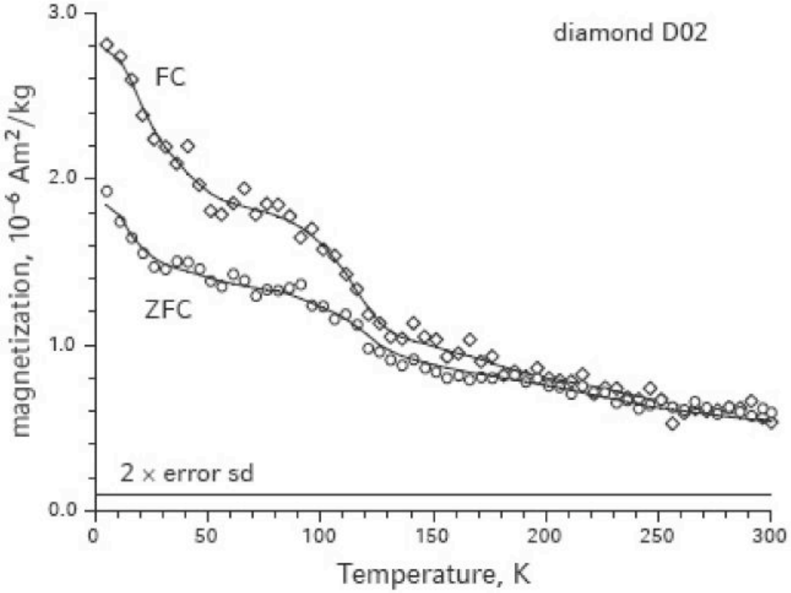


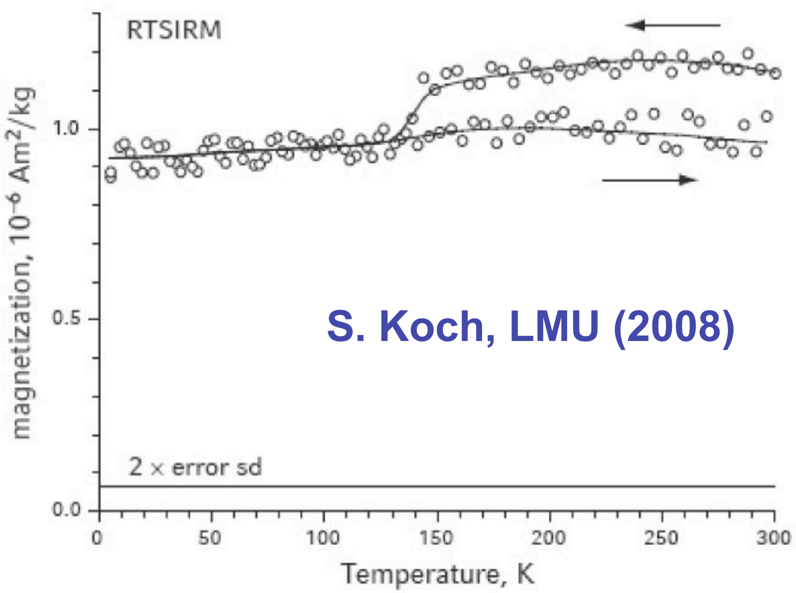
2.9-3.2 Ga eclogitic sulphide inclusions: De Beers, Jwaneng, Koffiefontein, Orapa

From: S Richardson, UCT

We are primarily exploiting the multivariate signatures of the magnetic properties at low temperature. This is because most minerals undergo marked phase transitions whose characteristics are sensitive to size, composition, oxidation state and strain history.

Example of the Verwey transition typical of magnetite.
The smeared-out transition in the field cooling (FC) and zero field cooling (ZFC) experiments, together with no magnetic memory seen in the room temperature SIRM data suggest this magnetite is oxidized. Why/when?





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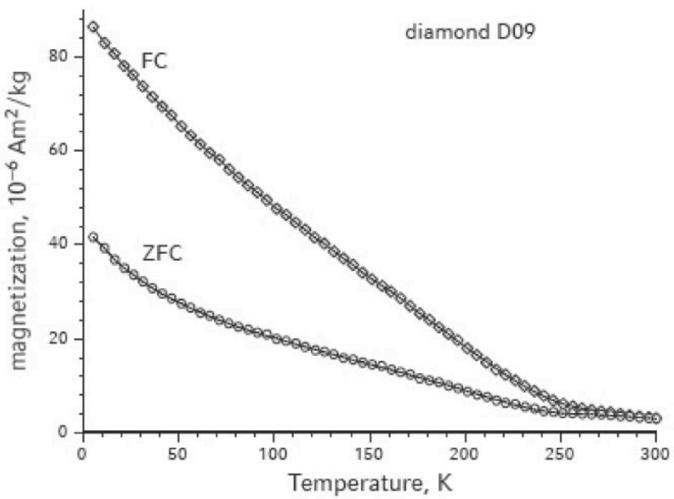
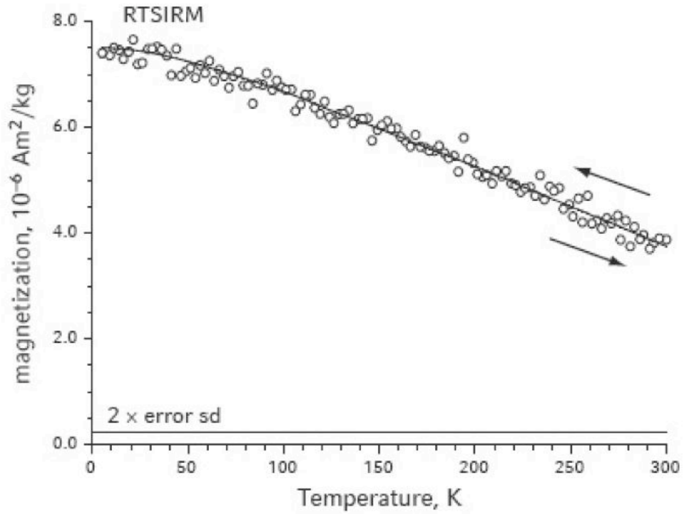
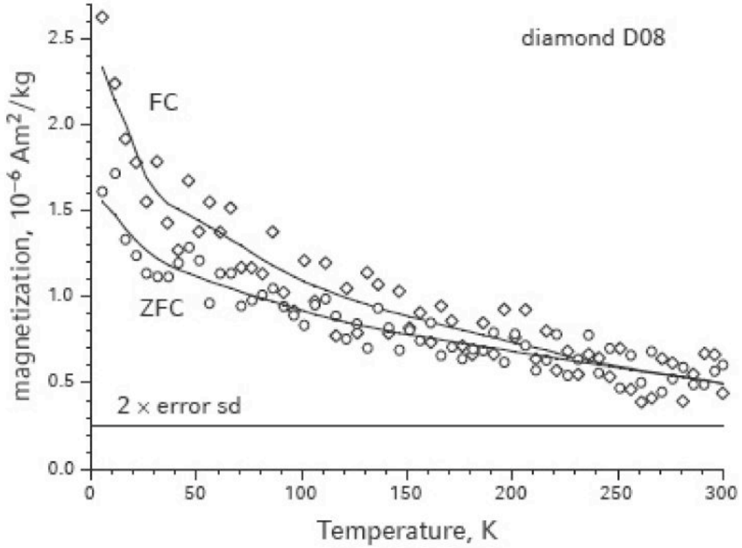
Here are other examples showing the likely presence of hematite (D09) and pyrrhotite (D08). If hematite, then when did oxidation occur?







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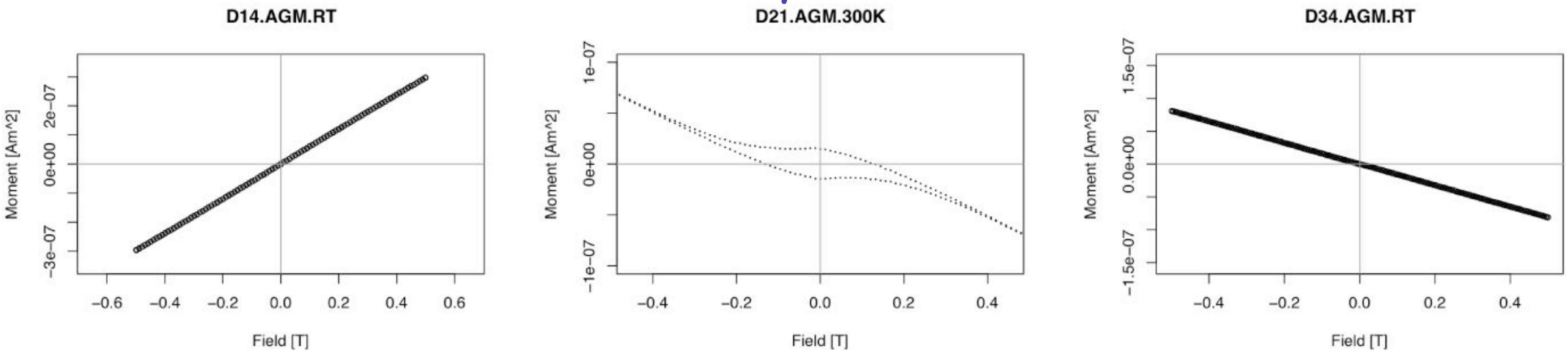
Magnetic hysteresis experiments give further evidence for the type of inclusions in diamonds. Most diamonds are diamagnetic (figure on right), some are paramagnetic (left) and many have both diamagnetic and ferromagnetic signatures (center). Performing these kind of experiments at low temperature helps further define the uniqueness of each and every diamond.



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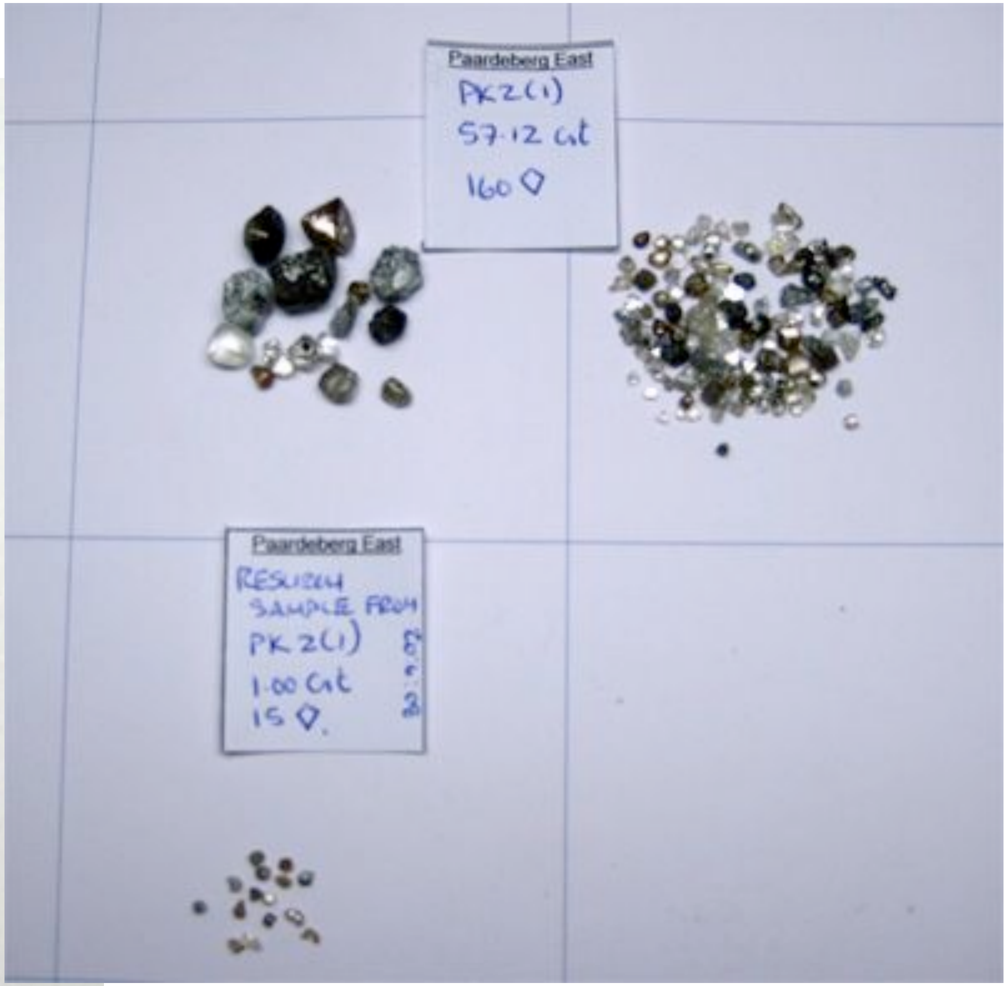
Placer deposits CAR,
reworked and
derived from Cretaceous
placers


Paardeberg East
RESURCH
SAMPLE FROM
PK 2(1)
1.00 Ct
15 ◊.


Paardeberg East
PK2(1)
57.12 Ct
160 ◊
Paardeberg East
RESURCH
SAMPLE FROM
PK 2(1)
1.00 Ct
15 ◊.

!Khure Diamond Project
Diamond batch #2

DESCRIPTION OF DIAMONDS FROM PK2 (1), South Africa

Magnetism should ultimately give crucial insights into the genesis (mantle chemistry, depth, etc.) of diamonds.