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Use of X-ray CT to investigate microwave induced cracks

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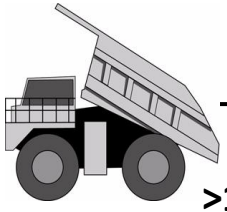
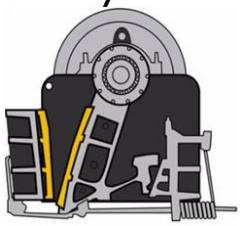
Background



Run of mine ore

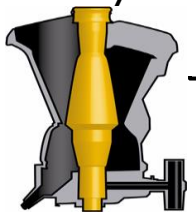
>1000 mm

Primary Crushers



< 100mm

Secondary Crushers

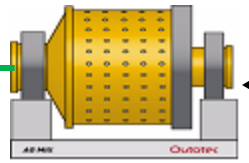


< 10 mm

Microwave treatment

1~3 kWh/t

Tertiary Crushers



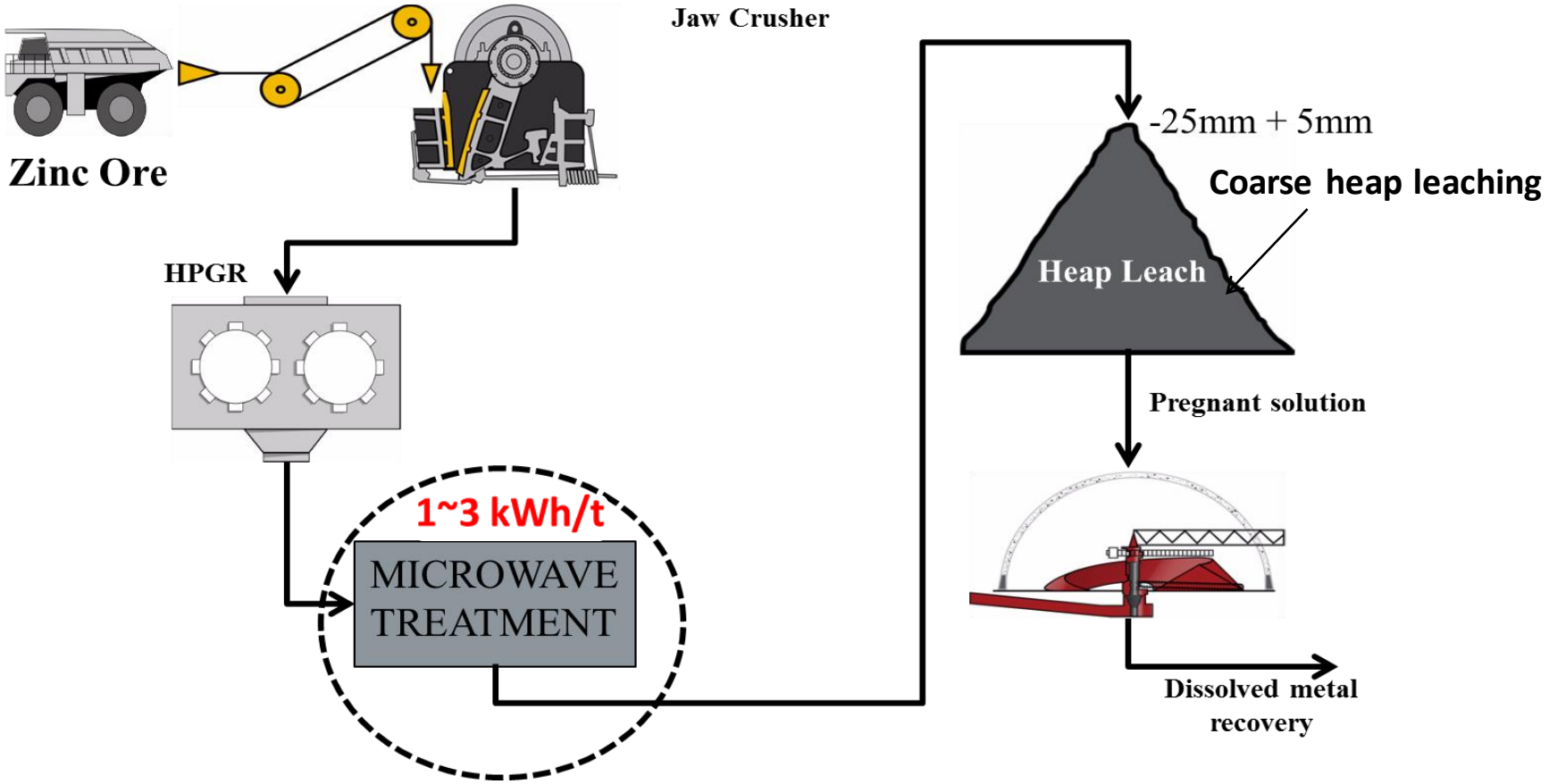
< 100 µm

Metals recovery

- Concentration
  Flotation, Gravity concentration
- Hydrometallurgy
  Leaching, Electrolysis, Precipitation
- Pyrometallurgy
  Smelting, Refining

- Induced micro fractures and cracks in the ore
- Increased liberation
- Reduction of the work index

Proposed flow sheet

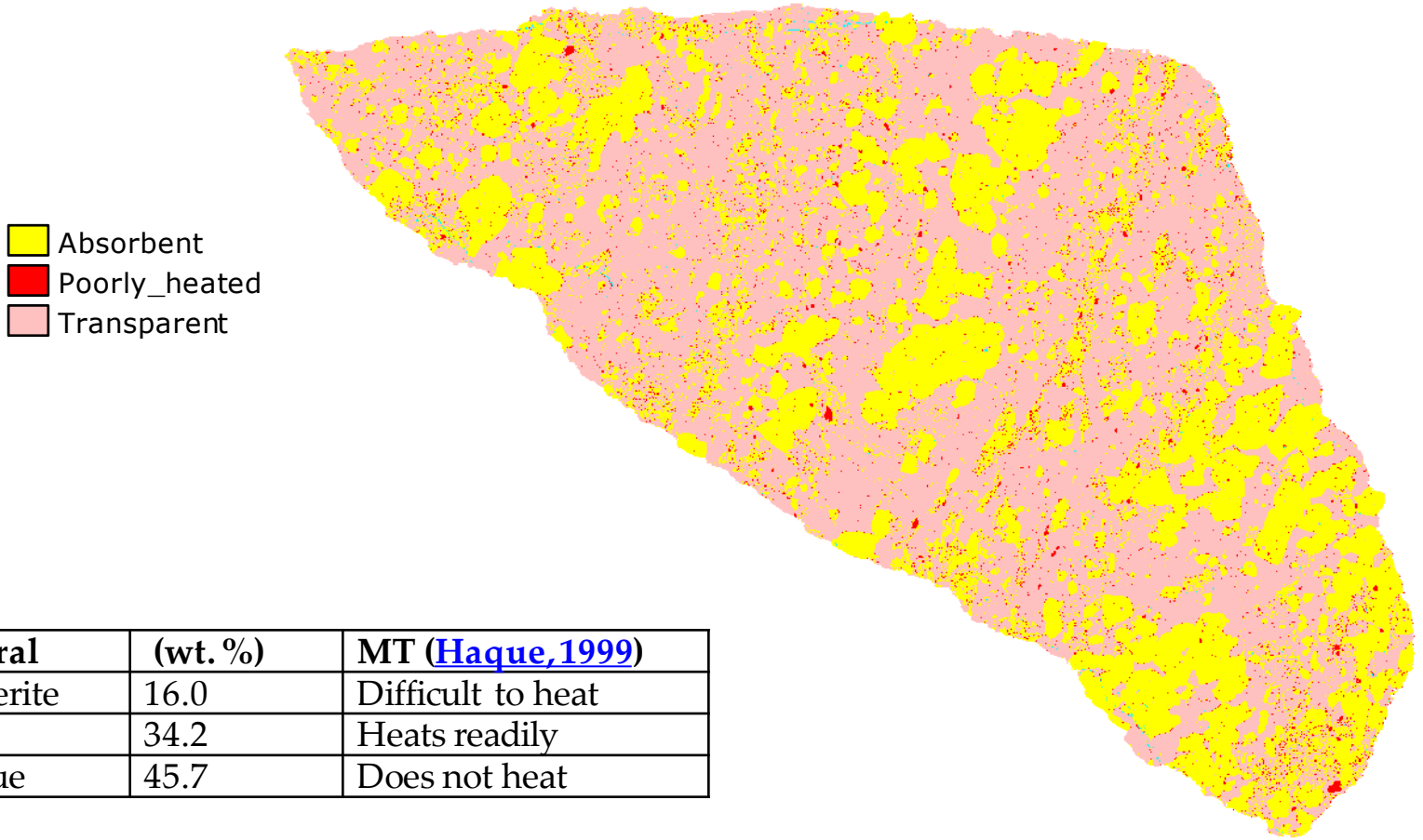


- Develop optimal energy efficient flow sheet for exploiting microwave induced grain boundary fractures

Objectives

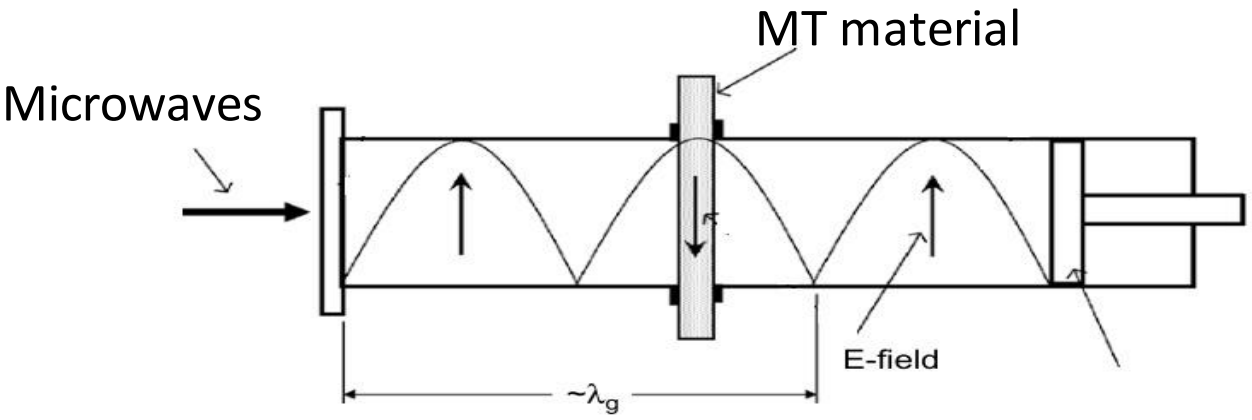
1. Ascertain the microwave treatment response of Gamsberg Zinc ore
2. Develop and apply methods to measure and quantify microwave induced damage
3. Determine the downstream heap leaching benefits of microwave treatment

Methodology- QEMSCAN



Mineral	(wt. %)	MT (Haque, 1999)
Sphalerite	16.0	Difficult to heat
Pyrite	34.2	Heats readily
Gangue	45.7	Does not heat

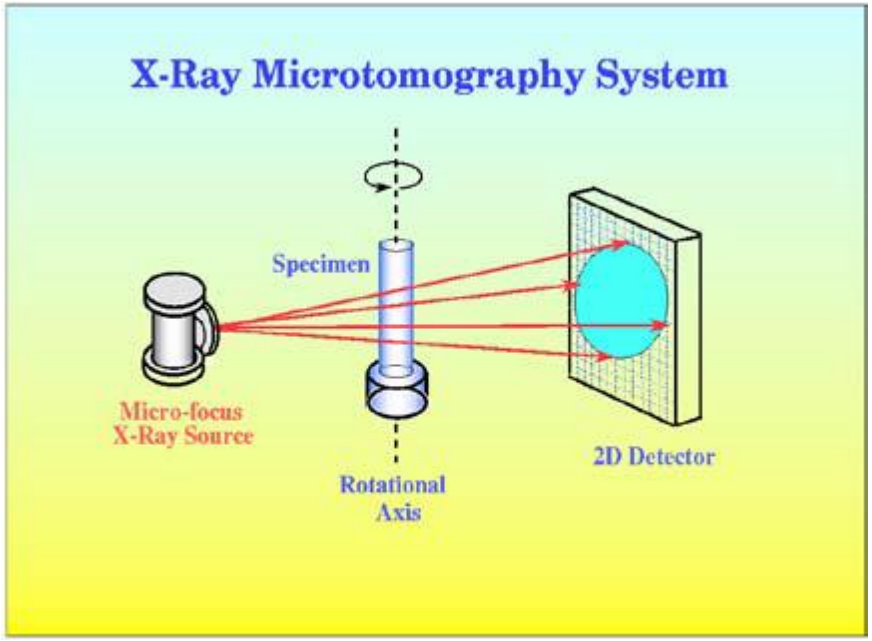
Microwave treatment



Size (mm)	Forward applied power (kW)	Reflected power (kW)	Time (sec)	Actual energy input into ore sample (kWh/t)
(-25+19)	5.92	0.93	1	2.11
(-16+9.5)	5.50	0.53	1	2.65
(-5+4.75)	5.56	0.71	1	2.37

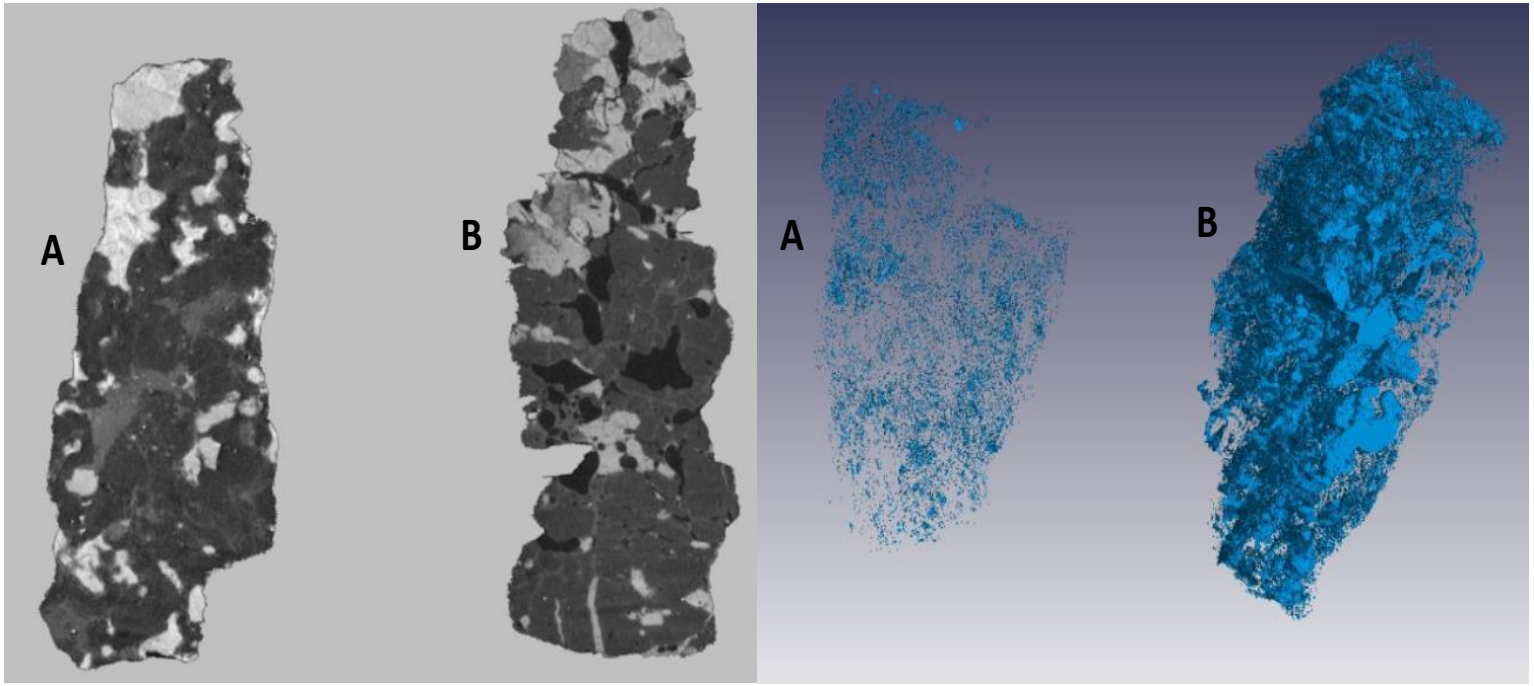
- 6 kW power supply ,
- 2.45 GHz microwave transmission system

Methodology- X-ray CT



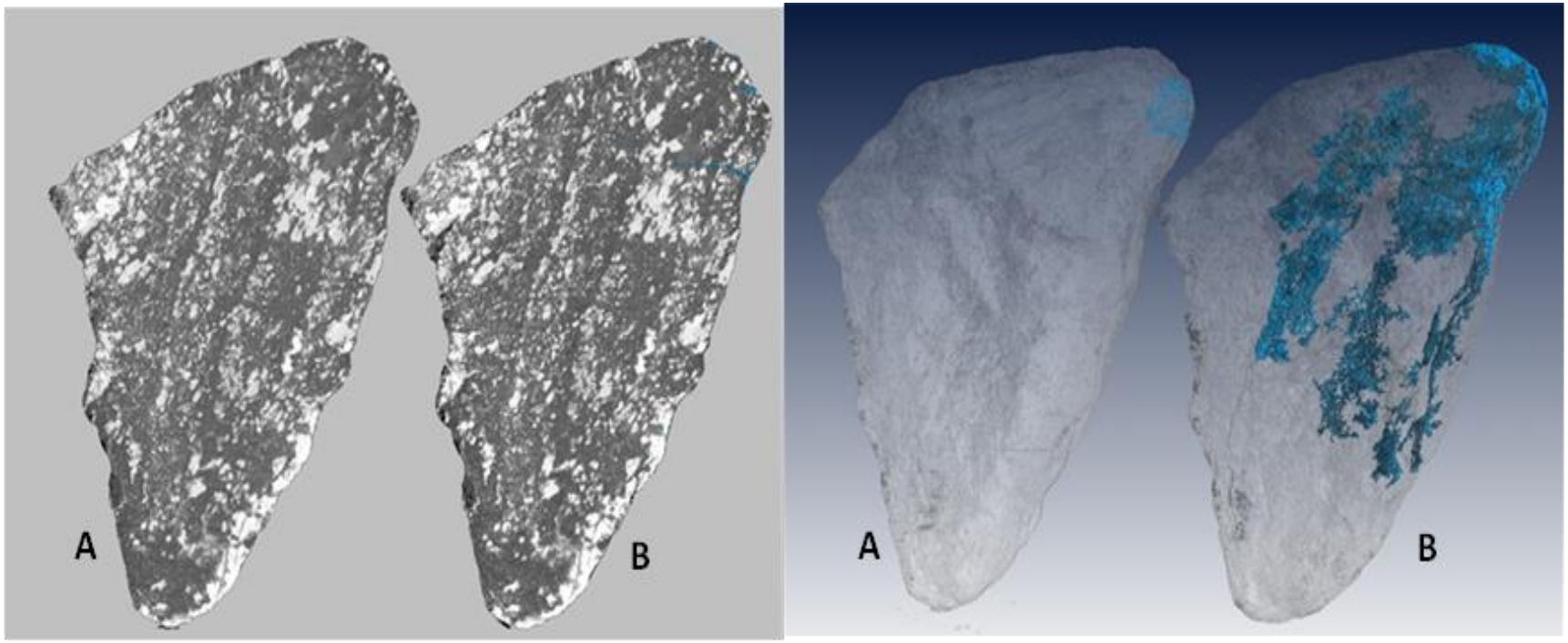
Minerals	Density g/cm^3	Effective atomic number Ze
Pyrite	5.01	22.06
Sphalerite	4.05	27.15
Quartz	2.62	14.42

X-ray CT results



Left (-5+4.75) mm HPGR crushed, right 3D crack view, (A- untreated, B-microwave treated)

X-ray CT results



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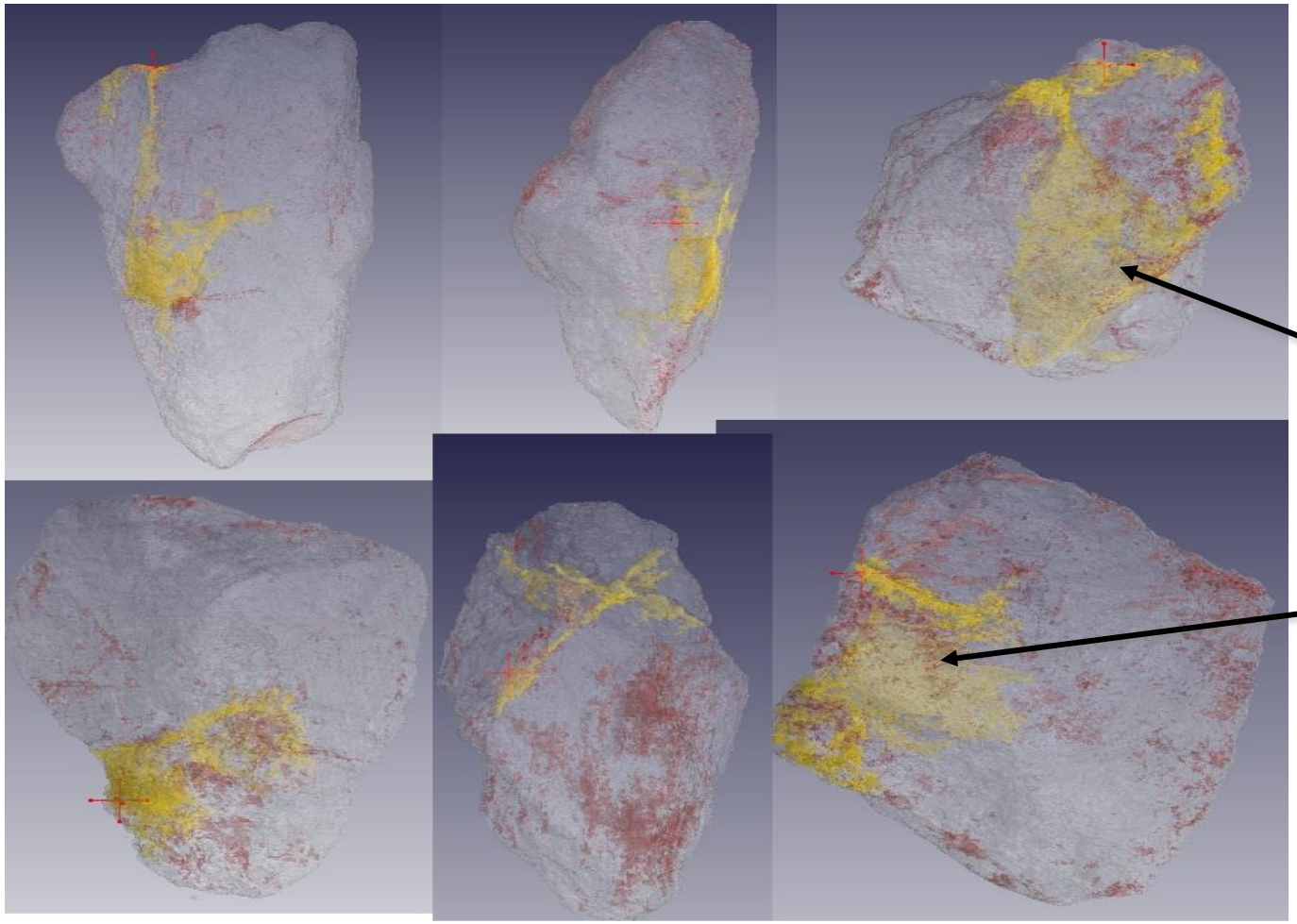
X-ray CT results

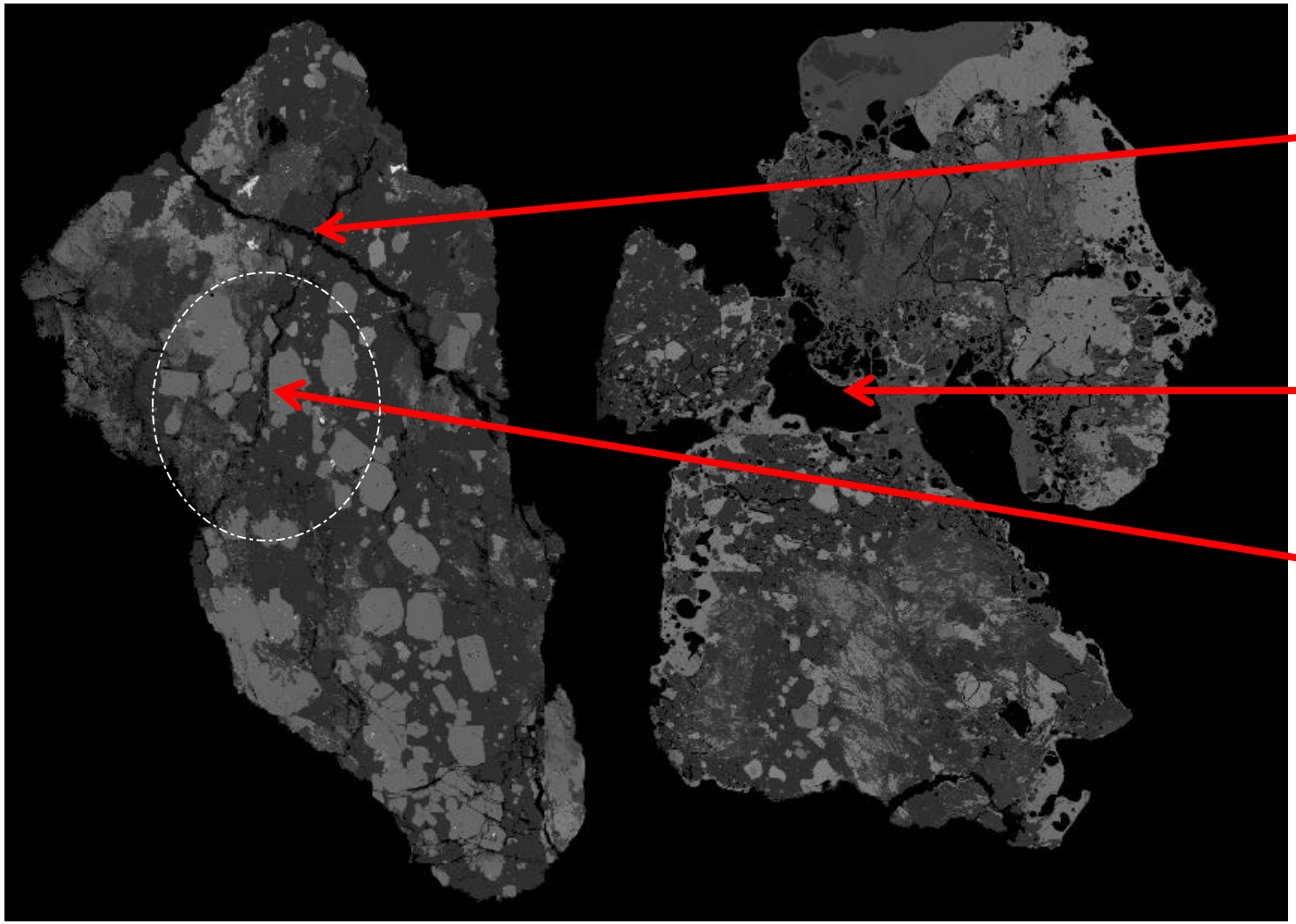


Small
(-5+4.75) mm

Medium
(-16+9.5) mm

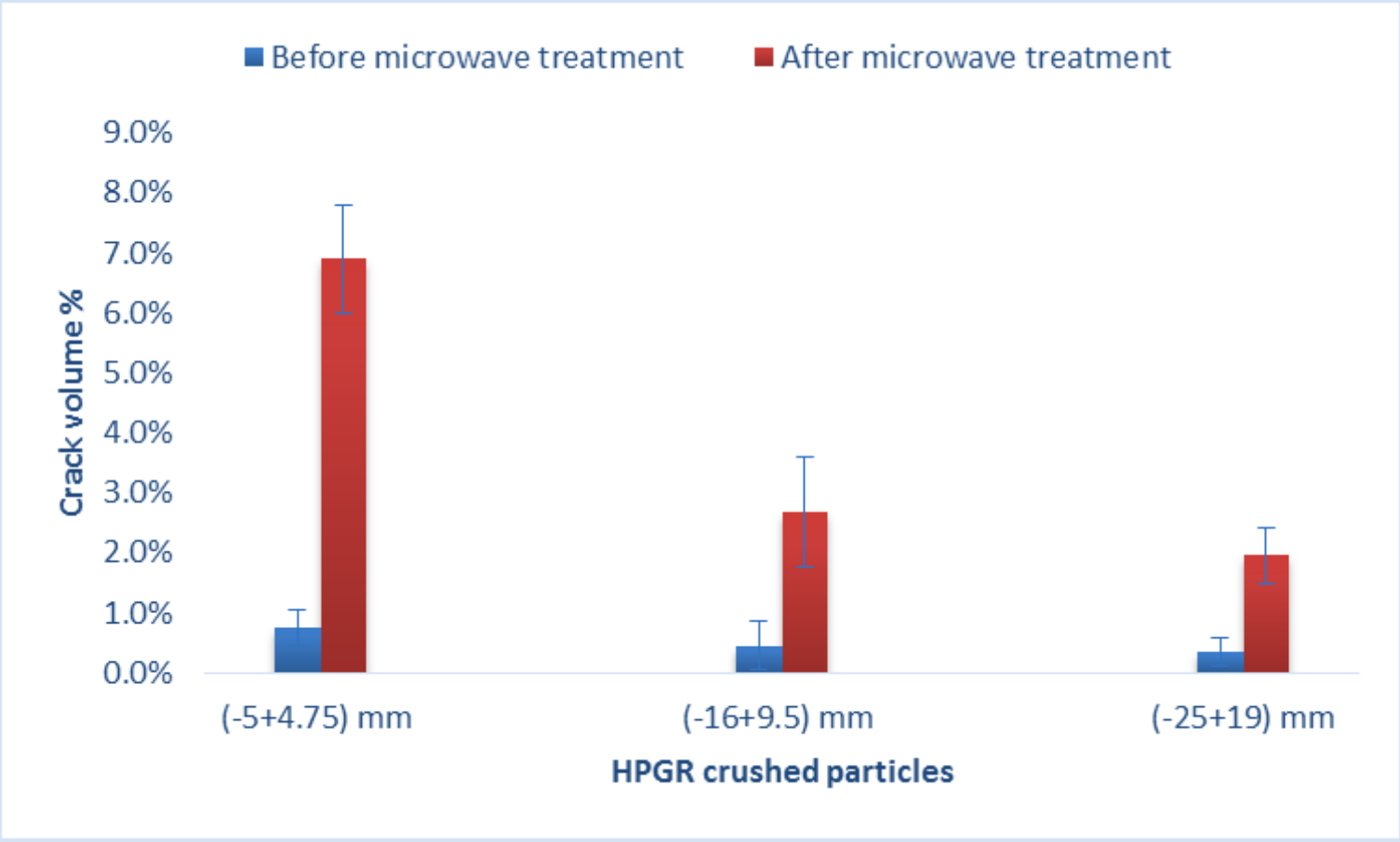
Large
(-25+19) mm

X-ray CT results



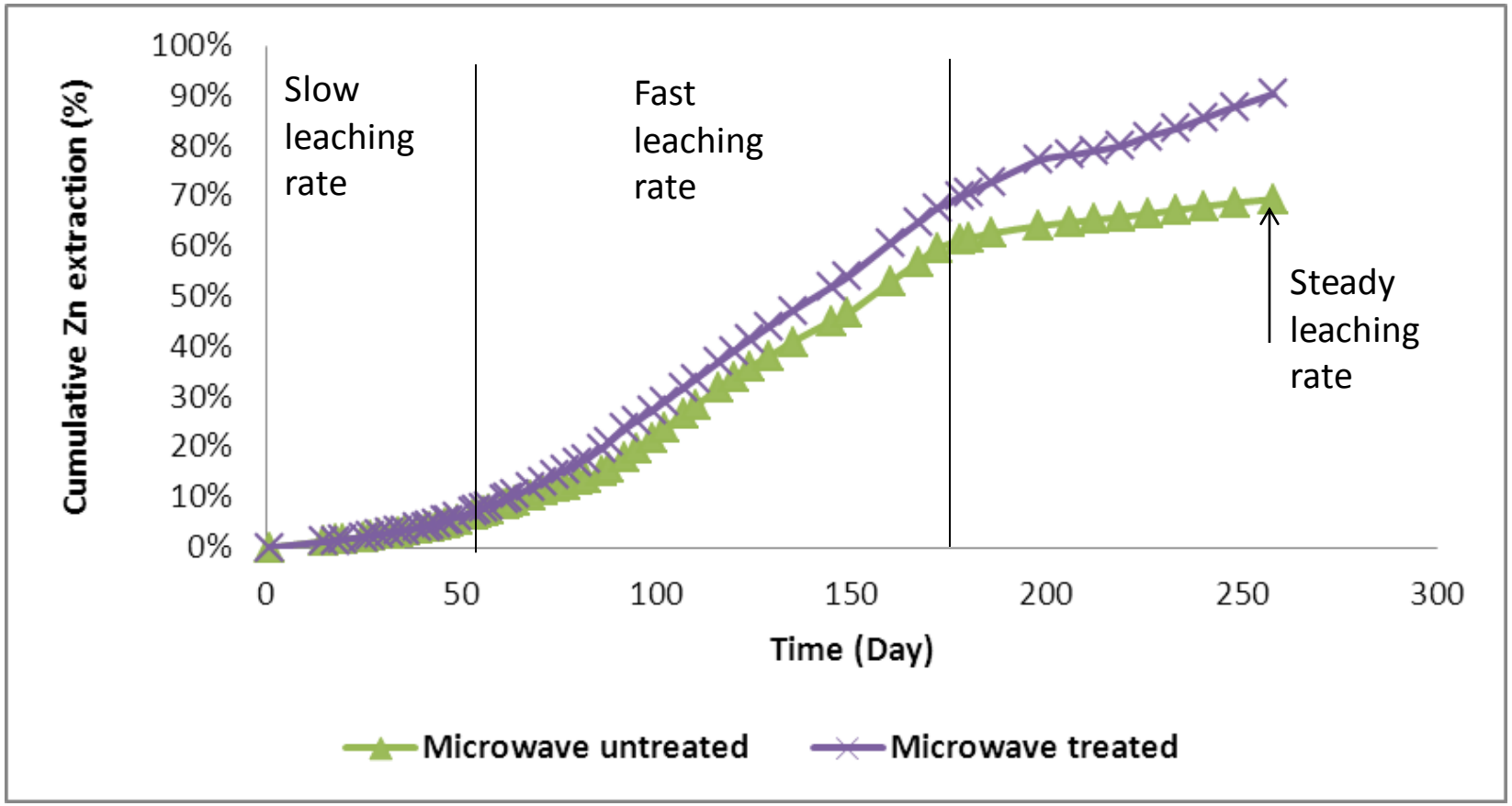
Small (-5+4.75 mm)

X-ray CT results



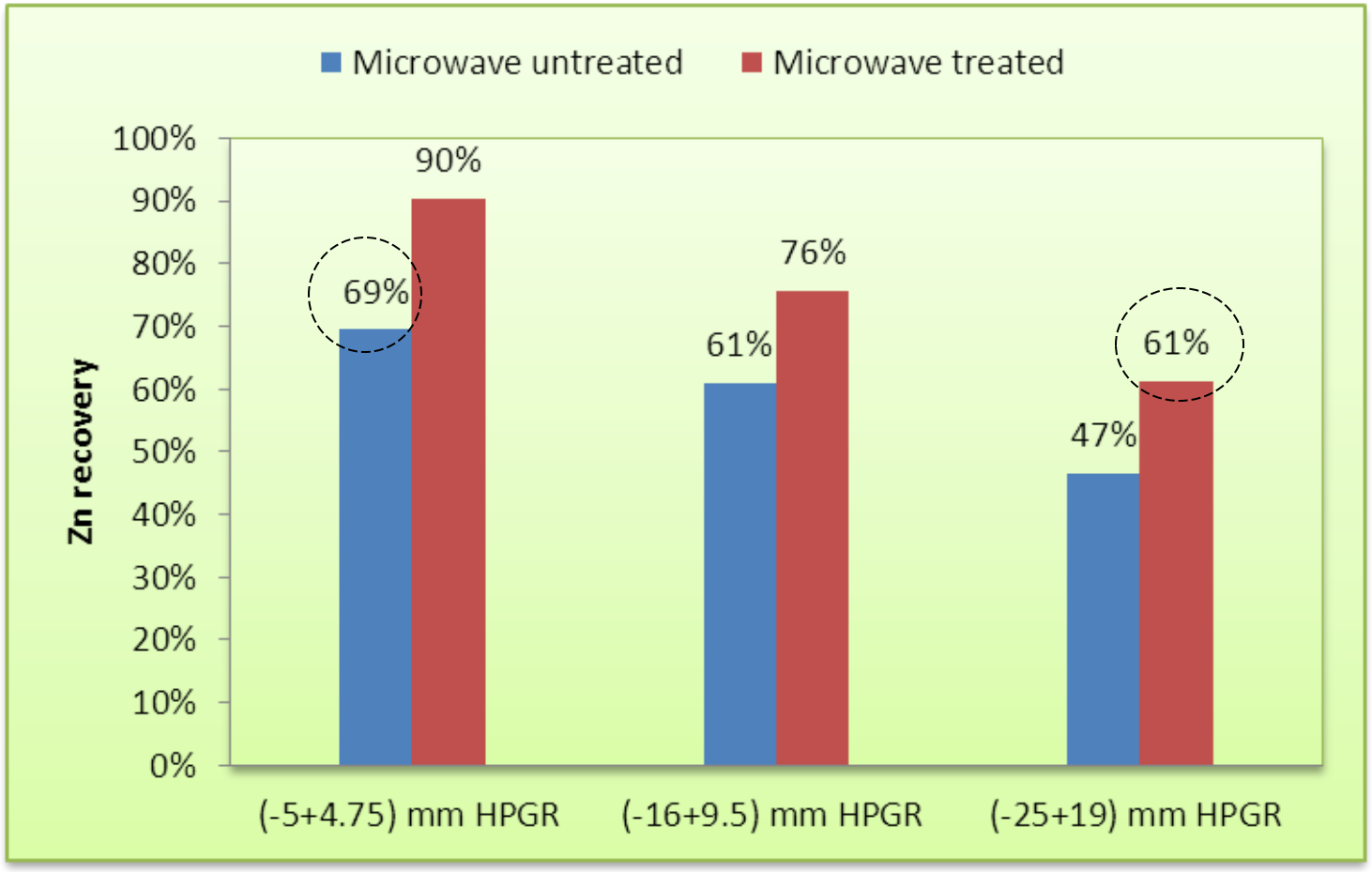
Mean crack volume values and standard deviation for HPGR crushed particles before and after microwave treatment

Leaching results



Cumulative Zn recovery of HPGR (-5+4.75)mm crushed particles

Leaching results



Overall Zn extraction after 270 days of column leaching

Conclusions

- Gamsberg Zinc ore is amenable to microwave treatment at economical microwave treatment levels (**1~3KWh/t)**
- A methodology for quantifying microwave induced damage has been developed.
- Significant improvement in coarse heap leaching mineral recovery due to microwave treatment (15% to 20% increase in heap leach recovery)

Acknowledgements

- Dr Megan Becker and Prof Jochen Petersen, University of Cape Town
- Anton du Plessis, Stellenbosch University CT Scanner

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Thank you

"The most efficient way to break rock, is not to break rock at all"

Dr Rob Morrison, JKMRC

Source: Elizabeth Lewis-Gray, Chairman, CEEC Presentation to SAIMM, February 2012