

## Soil Susceptibility and Landmine Detection

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### Structure

- Soil susceptibility (absolute)
- Frequency dependent susceptibility
- Spatial variability
  
- Relevance for test lanes

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## Investigation of the susceptibility of lateritic soils from the recent tropics

### samples from 15 different countries

- Australia
- Brazil
- El Salvador
- Ghana
- Guatemala
- Hawaii
- India
- Madagascar
- Mexico
- New-Caledonia
- Philippines
- Puerto Rico
- Sri Lanka
- Uganda
- Venezuela

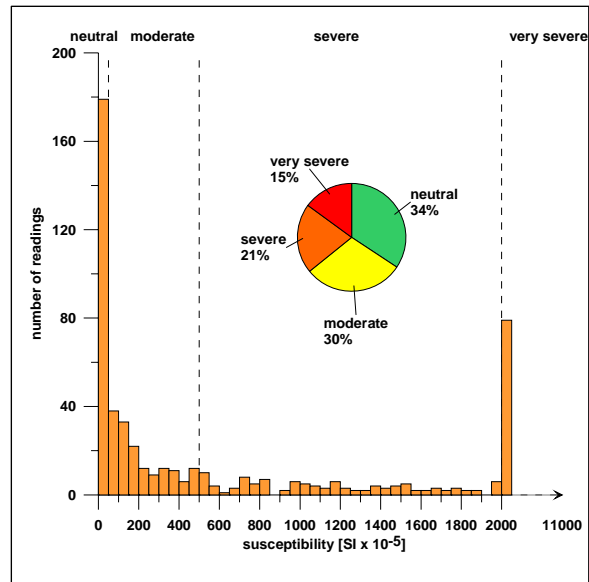


### 6 groups of parent material

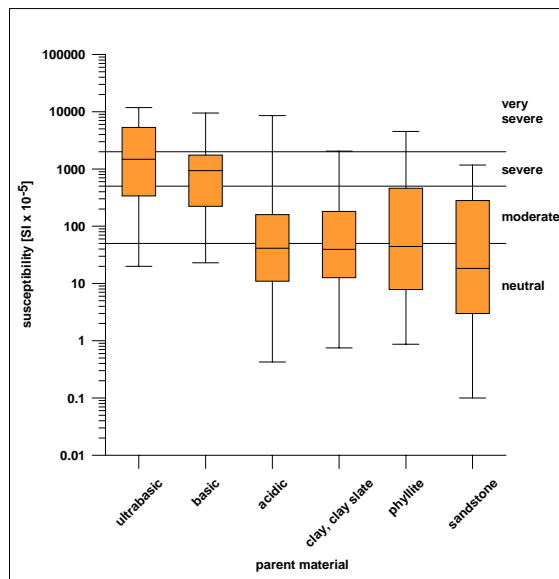
- ultrabasic igneous rocks
- basic & intermediate igneous rocks
- acid igneous rocks
- clay, clay slate
- phyllites
- sandstones

A total of 520 soil samples has been investigated

## Susceptibility of tropical soils



## Susceptibility of soils with different parent rocks



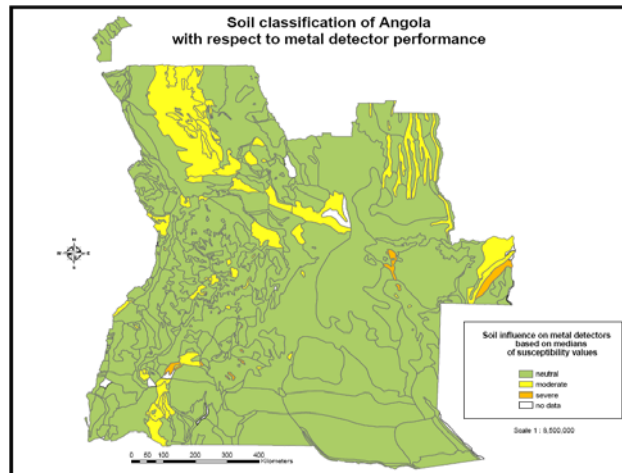
### Classification of susceptibilities as to parent material and weathering

Parent Rock	Ignoring Weathering	Degree of Weathering		
		0 - 1	1 - 3	> 3
ultrabasic	● ●	● ●	● ●	● ●
basic/ intermediate	● ●	● ●	● ●	
acid	● ●	● ●	● ●	● ●
Clay/ -slate	● ●	● ●	● ●	● ●
Phyllite	● ●	● ●	● ●	
Sandstone	● ●	● ●	● ●	● ●

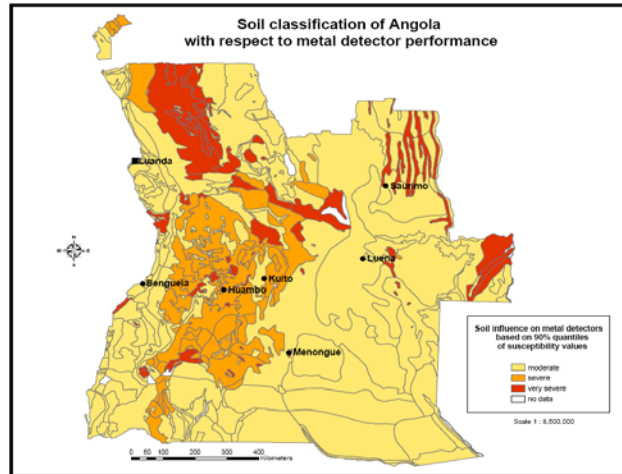
- Limitations of Metal Detector:**
- neutral (0 – 50 \* 10<sup>-5</sup> SI)
  - moderate (50 – 500)
  - severe (500 – 2000)
  - very severe (> 2000)



### Soil susceptibility of Angola



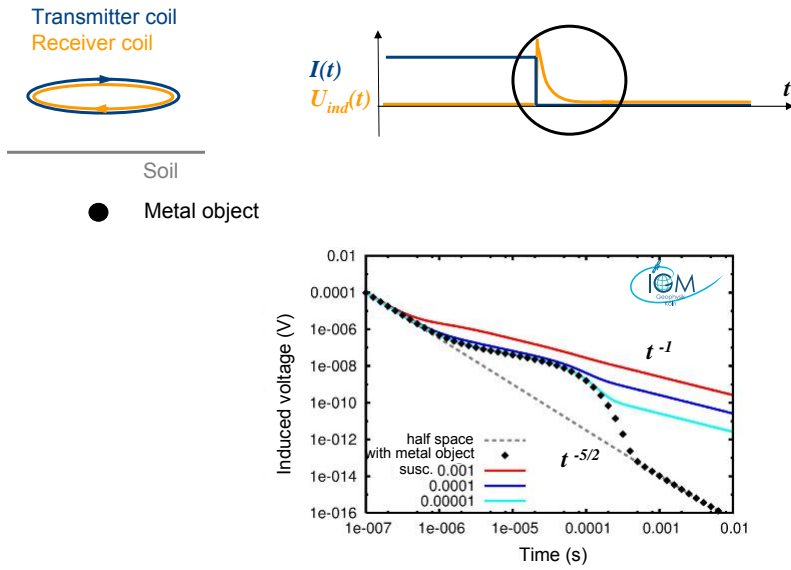
## Soil susceptibility of Angola



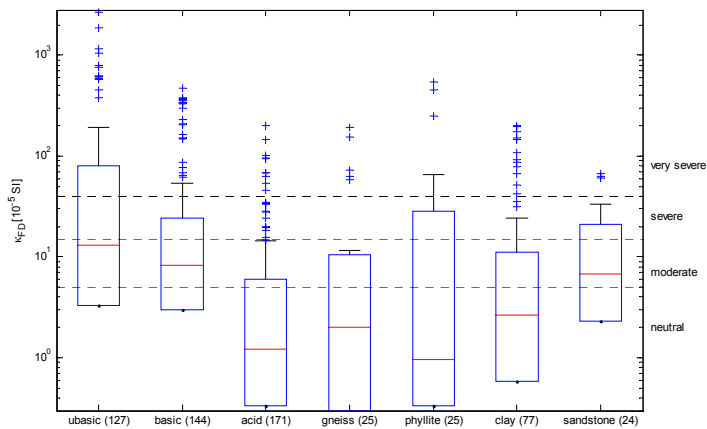
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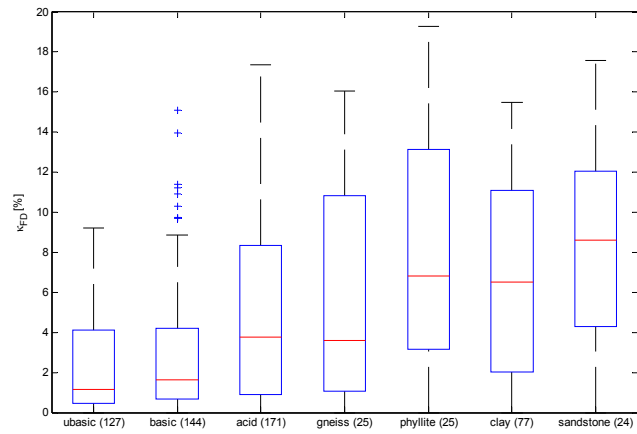
## Time domain metal detector at frequency dependent susceptibility



## Classification of frequency dependence (absolute) of tropical soils



### Relative frequency dependence as indicator for soil development



### Frequency dependence of susceptibility of hard rocks

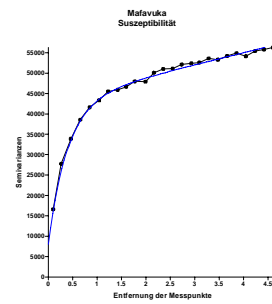
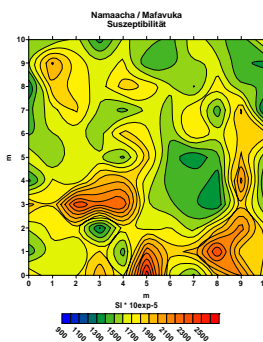
	LF susceptibility $SI \cdot 10^{exp-5}$	Frequency dependence %
Volcanic glass Antarctica	1,551 – 2,165	8.3 – 9.4
volcanic current of ashes & Trachyte Vogelsberg drilling	62 - 172	3.8 – 6.0
Basalt Jan Mayen	209	3.8
Volcanic tuffstone Messel drilling	64 - 194	4.2 – 6.7
Quarternary basalt lava Eifel mountains	668	5.1
Basalt Etna Mountain	453	2.7
Rhyolite Mozambique	1,194	11.1

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## Spatial variability of susceptibility

### Former minefield in Mozambique

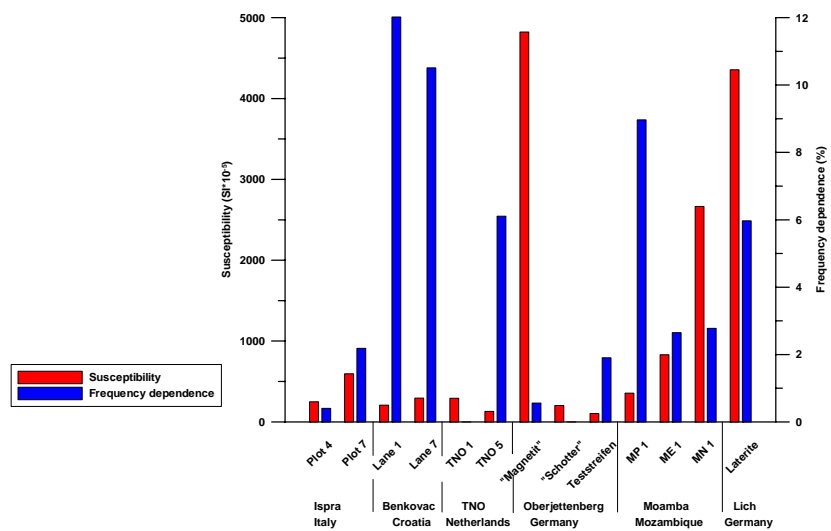


$$\bar{\kappa} = (1.650 \pm 238) \text{ SI} * 10^{-5}$$
$$\text{cv} = 14 \%$$

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## Properties of soil material used in test lanes



## Ideal soil material for test lanes used for dual sensor tests

