

*40<sup>th</sup> Anniversary*

**Paka Volcano in the Northern Kenya Rift:  
Volcanic evolution, petrology  
and insights into its geothermal system**

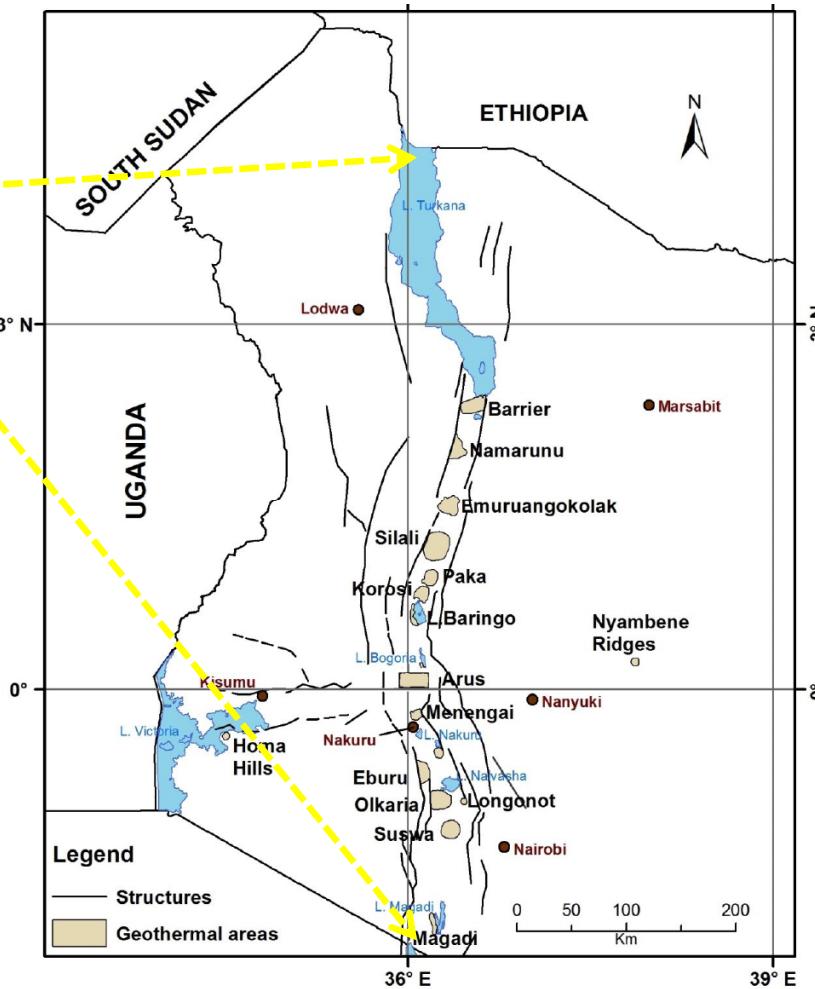
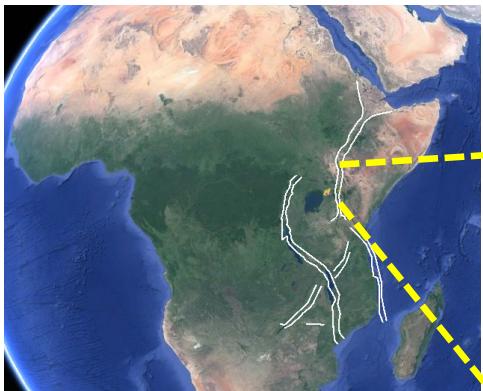
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- Statement of the problem
- Objectives
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- Timeline
- Budget

# Introduction



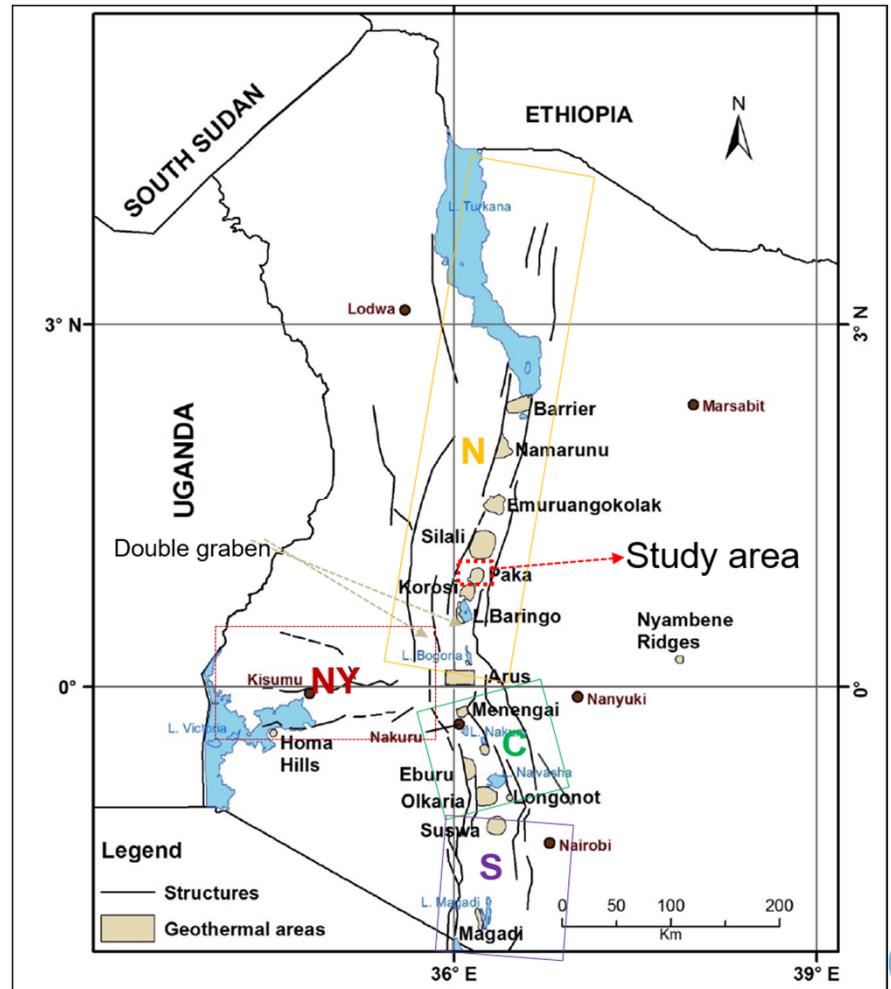
- East African Rift is mega volcano-tectonic structure
- EARS - 4000 km
- Complex history
- Volcanically active and rich in geothermal resources

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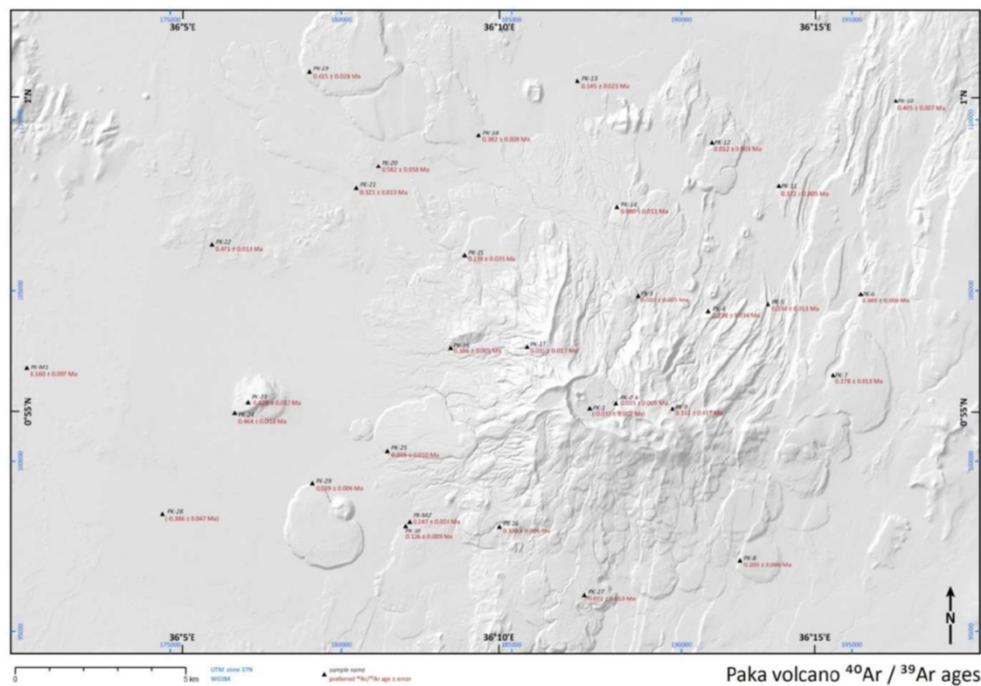
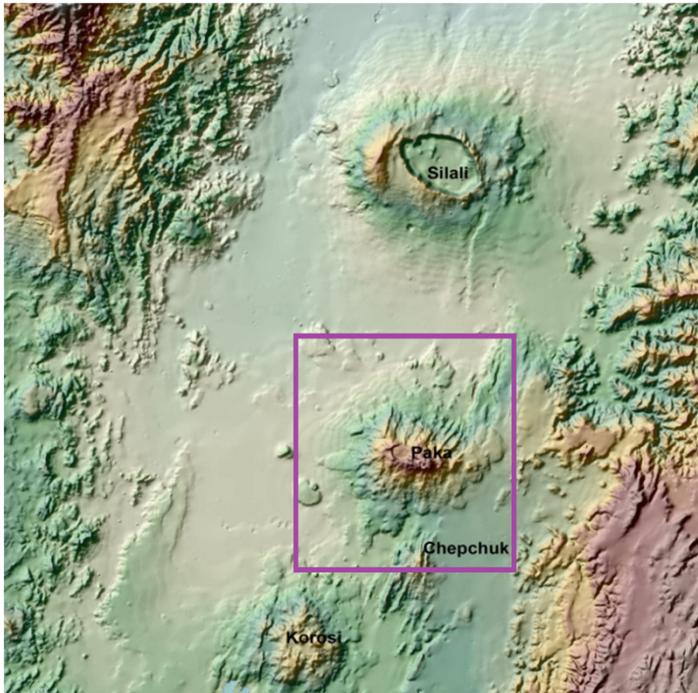


# Kenyan EARS

- Kenyan EARS - 900 km
- 3 segments: northern, central, southern
- Paka is in the northern segment south of Silali



# Paka volcano



Between Silali and  
Korosi

The volcano is  
earmarked for drilling

Rises to 1600 masl

1.5 km in size

Last eruption 8 Ka

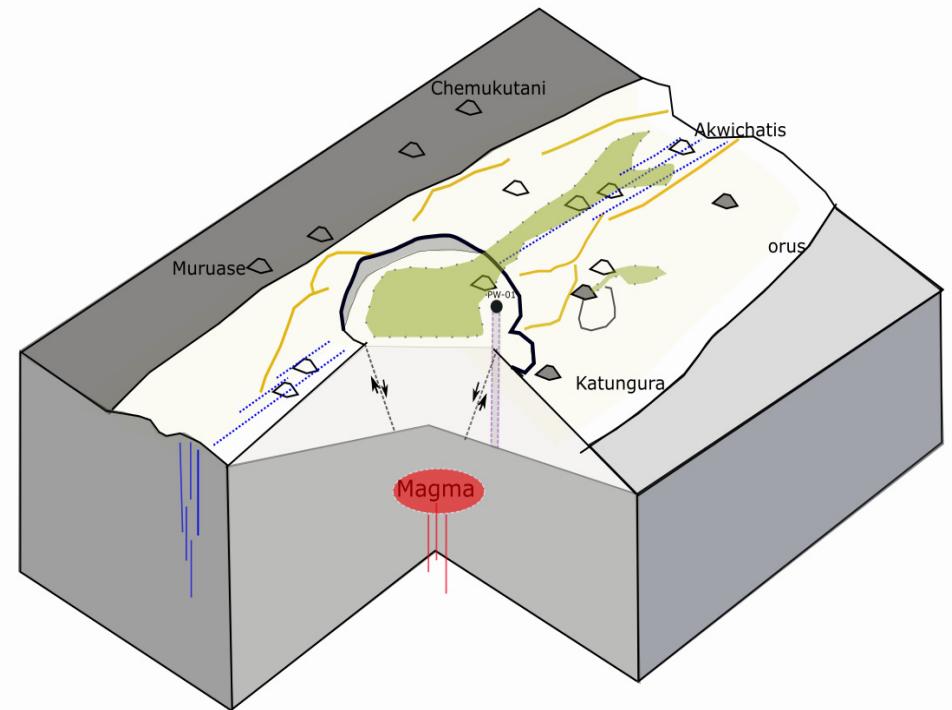


# Statement of the problem

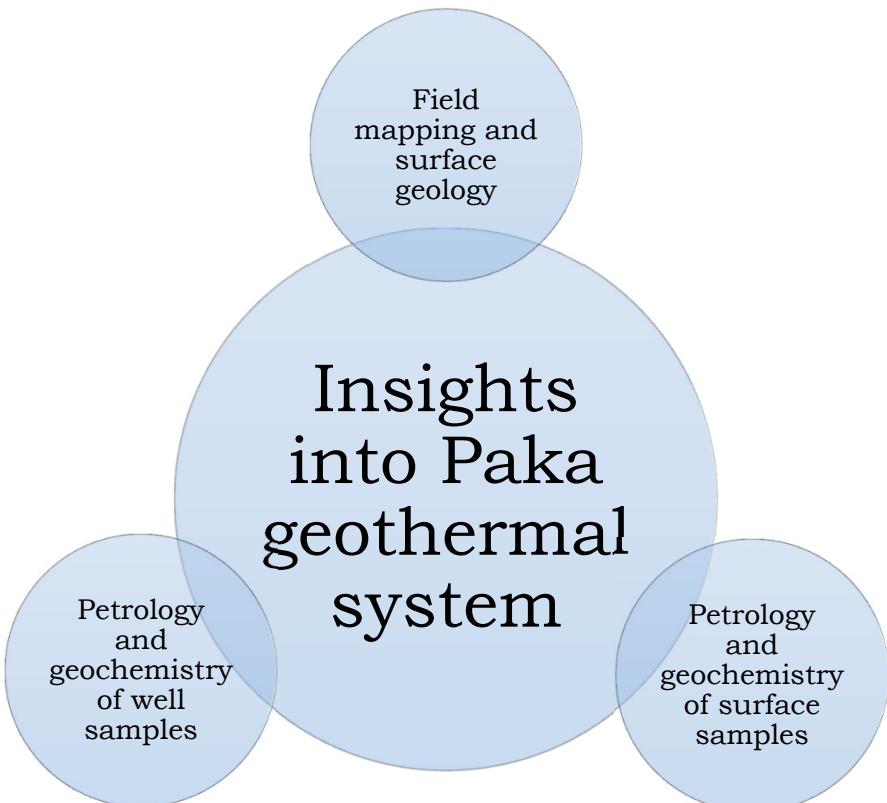
- GDC is to start drilling in Pako. It is therefore important to understand the volcano system better, as this will have implications on the geothermal development approach
- Early geological work hampered by scarce radiometric dates-comprehensive sequence of events is lacking and inconsistency in volcanic evolution history model
- Present petrology and petrochemistry data and their interpretation is insufficient  
- gaps in magmatic process, petrogenetic model is lacking
- Subsurface modelling largely on indirect data current drilling will avail direct data to understand underlying rocks and volcanic history

# Objectives

- Develop a geological map in a new stratigraphic framework
- Determine the relationship of the multiple eruptive centres
- Understand magmatic process under Paka, magma depth, temperatures and plumbing system
- Develop a petrogenetic model for felsic and mafic series



# Approach and methodology



## MAPPING

- **Field mapping** in the new stratigraphic framework so to understand the volcanic evolution and sequence of events in detail

## LABORATORY ANALYSIS

- **Surface samples** - Petrology and geochemistry
- **Subsurface samples** - Well logging of top 1000 m of Paka well (PW-01) to understand subsurface geology and contribute to volcanic evolution, understand magmatic process

# Field mapping

| Formation              | Age                | Volcanic Activity   |
|------------------------|--------------------|---------------------|
| Young Basalt           |                    |                     |
| Trachyte and Mugearite | 10±3ka             | INTRA CALDERA LAVAS |
| CALDERA FORMATION      |                    |                     |
| Pyroclastic Deposit    |                    |                     |
| Upper Basalt           |                    |                     |
| Upper Trachyte         | 10±4ka             |                     |
| Lower Basalt           |                    |                     |
| Lower Trachyte         | 219±6ka<br>390±6ka | SHIELD FORMATION    |

Old stratigraphic framework (Dunkley et al 1993

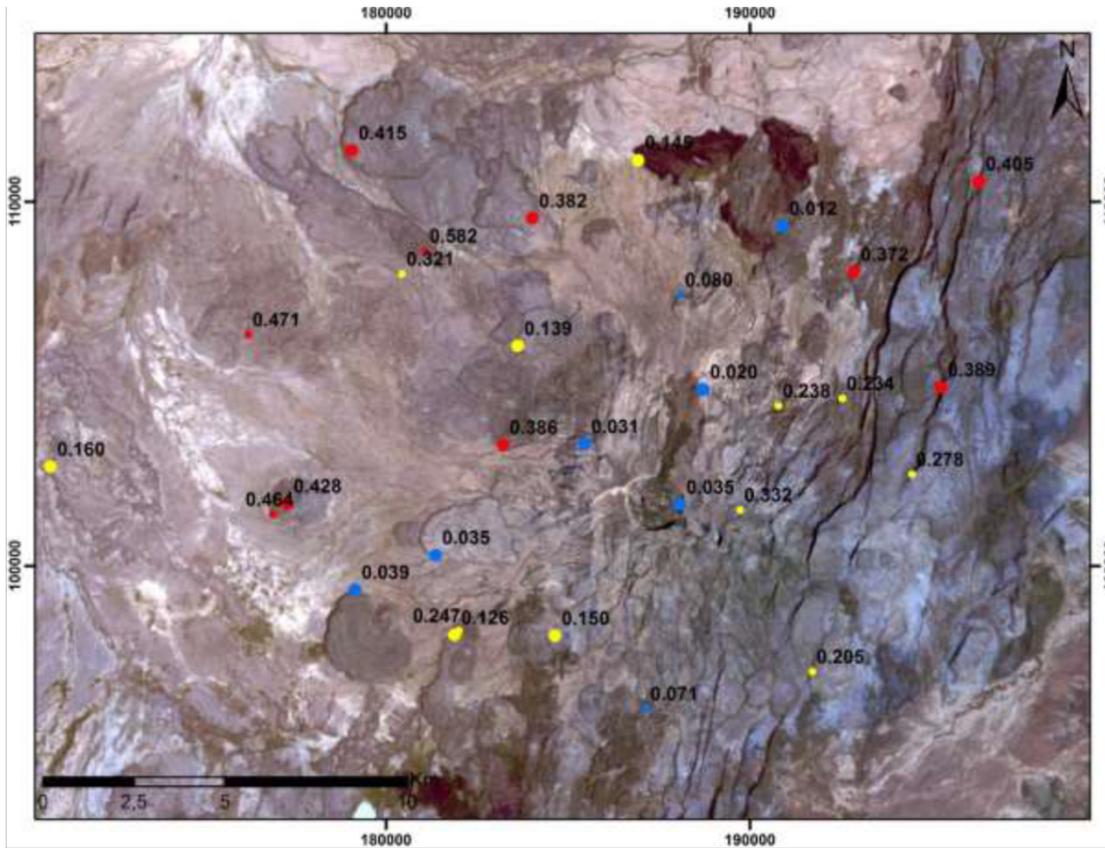
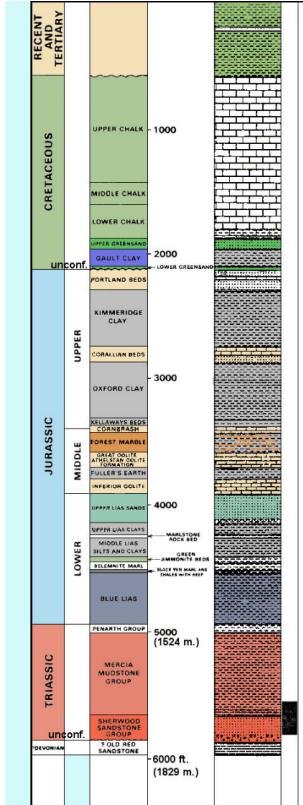
- Mapping in the new stratigraphic frame work
- Geology and structural

| Proposed name                     | code             | 40Ar/39Ar(ma) | Previous category   | Proposed grouping                    | Code              |
|-----------------------------------|------------------|---------------|---------------------|--------------------------------------|-------------------|
| Miocene                           |                  |               |                     |                                      |                   |
| Uncharacterised volcanics         |                  |               | Miocene             | Plateau                              |                   |
| Initial faulting Block faulting   |                  |               |                     |                                      |                   |
| Pliocene                          |                  |               |                     |                                      |                   |
| Sedimentations/lacustrine         |                  |               | Zanclean/Pliocene   |                                      |                   |
| Orus Trachyte                     |                  |               | Piacenzian/Pliocene |                                      | Pliocene trachyte |
| Middle Pleistocene                |                  |               |                     |                                      |                   |
| Pleistocene (Ionian)              |                  |               |                     |                                      |                   |
| older basalt                      | OBT <sub>1</sub> | .582          | Lower basalt        | older basalt (OBT)                   | OBT               |
| mugearite 1                       | Mg <sub>1</sub>  | .471          | mugearite           | mugearite                            | Mg                |
| older trachyte 1                  | LTv <sub>1</sub> | .428          | Upper trachyte      | Older trachyte(Tv)                   | Tv                |
| Lower basalt 1                    | LBT <sub>1</sub> | .389          | Lower basalt        | Lower basalts (LBT <sub>1</sub> )    | LBT <sub>1</sub>  |
| lower basalt 2                    | LBT <sub>2</sub> | .372          | Upper basalts       | Lower basalts (LBT <sub>2</sub> )    | LBT <sub>2</sub>  |
| Older Pyroclastic                 | LPy <sub>1</sub> | .332          | Lower trachyte      | Lower pyroclastic(LPy <sub>1</sub> ) | LPy <sub>1</sub>  |
| lower trachyte 3                  | UTv <sub>3</sub> | .321          | Lower trachyte      | Lower Trachyte (UTv <sub>2</sub> )   | UTv <sub>2</sub>  |
| Major Faulting east               |                  |               |                     |                                      |                   |
| upper trachyte 1                  | UTv <sub>1</sub> | .278          | Upper trachyte      | Lower Trachyte (UTv <sub>2</sub> )   | UTv <sub>2</sub>  |
| upper basalt 1                    | MBT <sub>1</sub> | .247          | Upper basalts       | Lower Basalts(LBT <sub>2</sub> )     | LBT <sub>2</sub>  |
| upper trachyte 2                  | UTv <sub>2</sub> | .234          | Lower trachyte      | lower Trachyte (UTv <sub>3</sub> )   | UTv <sub>3</sub>  |
| young basalt 1                    | UBt <sub>1</sub> | .160          | Upper basalt        | Upper basalts(UBt)                   | UBt               |
| young trachyte                    | UTv <sub>1</sub> | .139          | Young trachyte      | Upper Trachyte (UTv <sub>1</sub> )   | UTv <sub>1</sub>  |
| Pleistocene (Tarantian)           |                  |               |                     |                                      |                   |
| young trachyte                    | UTv <sub>2</sub> | .126          | Upper trachyte      | Upper Trachyte (UTv <sub>1</sub> )   | UTv <sub>1</sub>  |
| recent trachyte1                  | UTv <sub>3</sub> | .080          | Upper trachyte      | Upper Trachyte (UTv <sub>2</sub> )   | UTv <sub>2</sub>  |
| younger pyroclastic               | YPy              | .031          | Late pyroclastic    | Younger pyroclastic (YPy)            | YPy               |
| Faulting, subsidence and collapse |                  |               |                     |                                      |                   |
| recent trachyte 6                 | RTv <sub>1</sub> | .020          | Upper trachyte      | Recent Trachyte (RTv <sub>1</sub> )  | RTv <sub>2?</sub> |
| Holocene                          |                  |               |                     |                                      |                   |
| recent trachyte                   | RTv <sub>2</sub> | 0.012         | Upper trachyte      | Recent Trachyte (RTv <sub>2</sub> )  | RTv <sub>2</sub>  |
| Recent pyroclastic                | RPy              | 0.08          | Recent pyroclastic  | Recent Pyroclastic(RPy)              | RPy               |
| alluvial                          | Rsd              | recent        | alluvial            | Recent sediments(Rs)                 | Rs                |

Proposed new stratigraphic framework (Mibei et al 2018



# Petrology and geochemistry



- Surface samples
- Well log samples
- Top 1000 m  
i.e Pleistocene to Holocene
- Relevant to volcanic history



# Sample analysis

## ■ Surface and subsurface samples

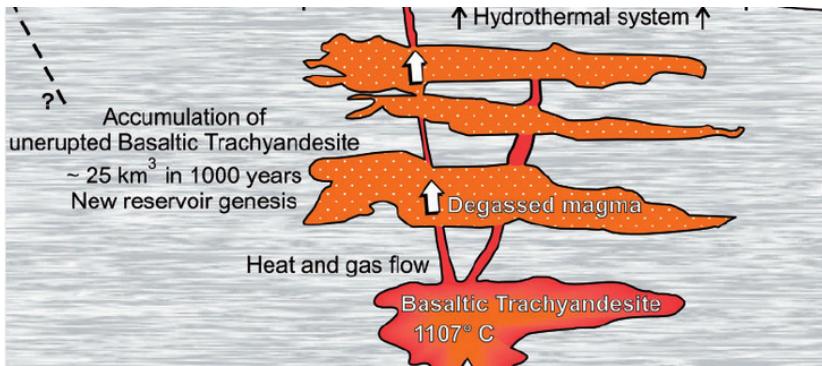
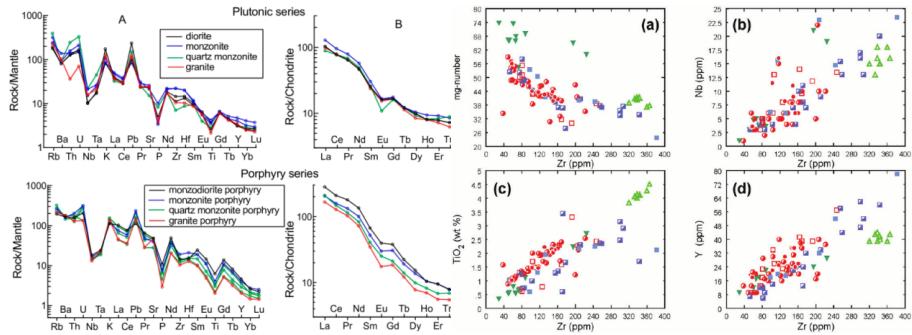
- Basalts, Intermediate and Trachyte, Pyroclastic and Xenoliths
- Samples from the surface - 40 samples
- Rock cuttings and cores - 110 samples

## ■ Analytical methods

- Petrography
- SEM and Microprobe
- Fluid inclusion
- ICP and isotopes

| Project samples for the analysis |         |     |      |          |
|----------------------------------|---------|-----|------|----------|
| Petrography                      | ICP     | SEM | EMPA | Isotopes |
| 55                               | 100-150 | 30  | 15   | 10       |

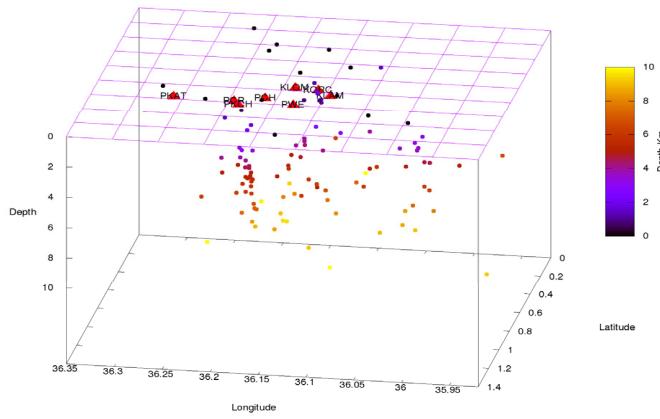
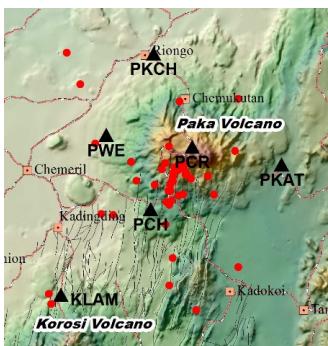
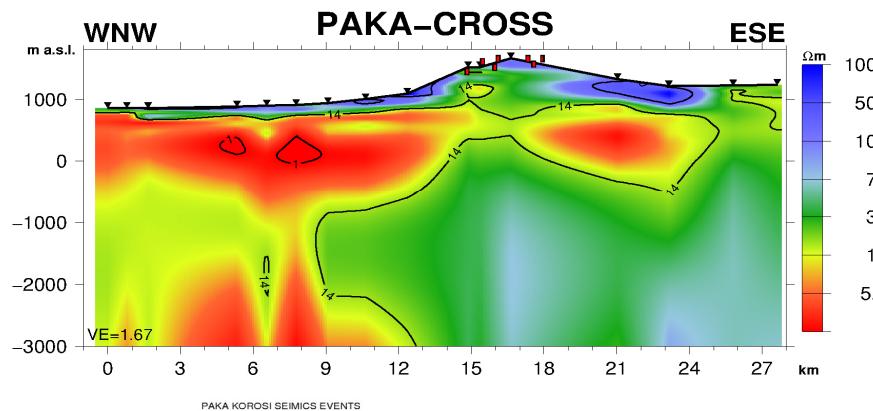
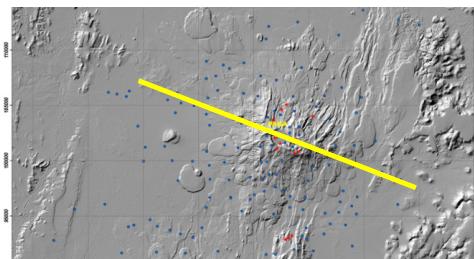
# Results



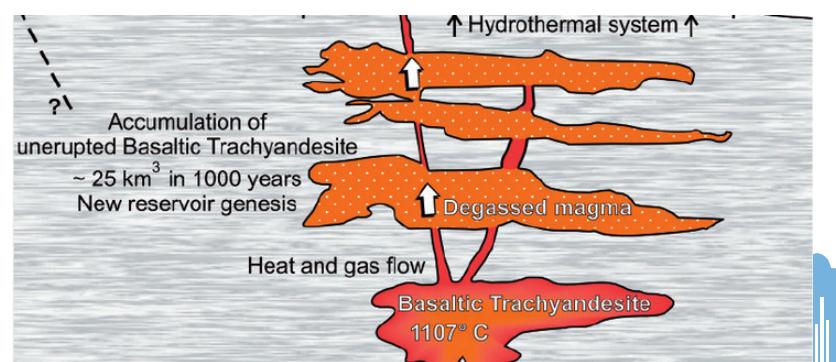
- Geological map
- Genetic correlation
- Fractional crystallization
- Melt fraction
- Geothermobarometry
- Magma depths
- **Assessment of magma processes hence geothermal heat source**



# Results



- Constrains to magma chamber and plumbing systems
- Geophysical data constrains



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# ASANTE SANA