



# **DJIBOUTI PROJECT PERSPECTIVES FOR THE TWO NEXT YEARS**

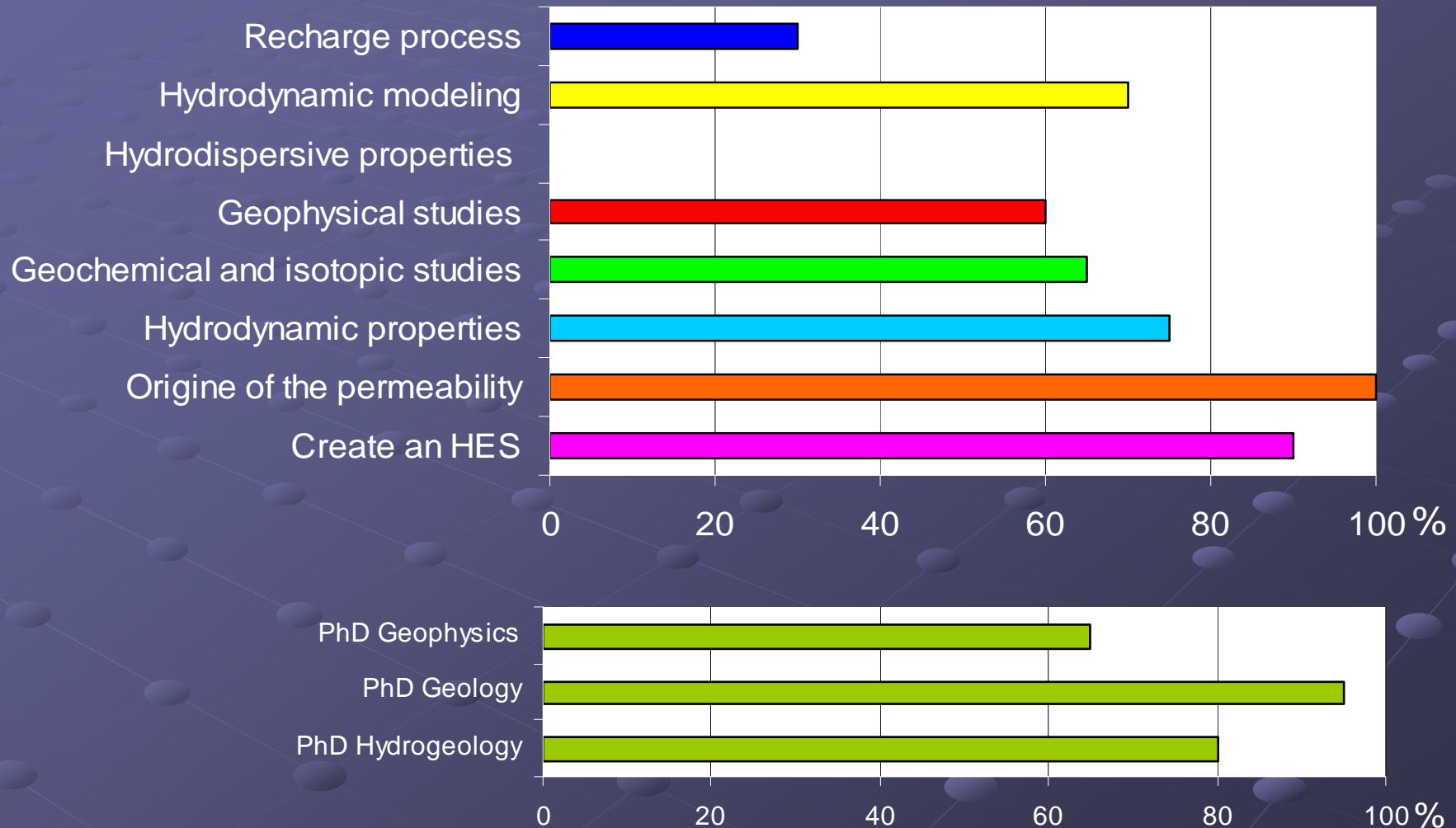
**MAWARI PROJECT ADDIS MEETING  
20-24 November 2007**

**JALLUDIN M**

# RECALL OF THE OBJECTIVES OF THE MAWARI PROJECT IN DJIBOUTI

- **Create an experimental area for hydrogeological studies**
  - **Origine of the permeability in fractured basaltic medium**
  - **Assess conductive and capacitive features of volcanic rocks**
  - **Assess hydrothermalism effects on recent volcanic rocks**
  - **Study hydrodynamic properties and analyse heterogeneity**
  - **Study the recharge process through wadi bed alluviums**
  - **Study hydrodispersive properties**
  - **Study geochemical and isotopic characteristics vis-à-vis to sea water intrusion and underlying saline waters**
  - **Analyse the reliability of the results for a local aquifer study**
  - **Apply results for modeling (flow, recharge, ...etc.)**
- 
- Training, workshops**
  - Exchange of scientists and students**
  - Publication**

# ESTIMATION OF THE ADVANCEMENT TOWARD THE OBJECTIVES OF THE PROJECT



## Hydrological budget

- **Realize topographical section of waddi Atar**
- **Install 2 more rain gauges in the upstream part of the catchment in order to obtain a better evaluation of the precipitations**
- **Measure run-off speeds with floats**
- **Estimate instantaneous run-off rate vs height, based on available and measured data**
- **Evaluate the hydrological budget for the Atar catchment**

## Geology

- **Hydrothermal minerals analysis on the core samples**

## Geochemistry and isotopes

- **Monitoring of the HES**
- **Frequent measurements for recharge effects on the aquifer: samples and profiles**
- **Major elements and trace elements**
- **Try to isolate underlying saline waters for sampling**
- **Stable isotopes: deuterium,  $^{18}\text{O}$**
- **Other isotopes: strontium, borum**
- **Chemical equilibrium analysis and modeling**
- **Geothermometry**

## Hydrodynamic and hydrodispersive studies

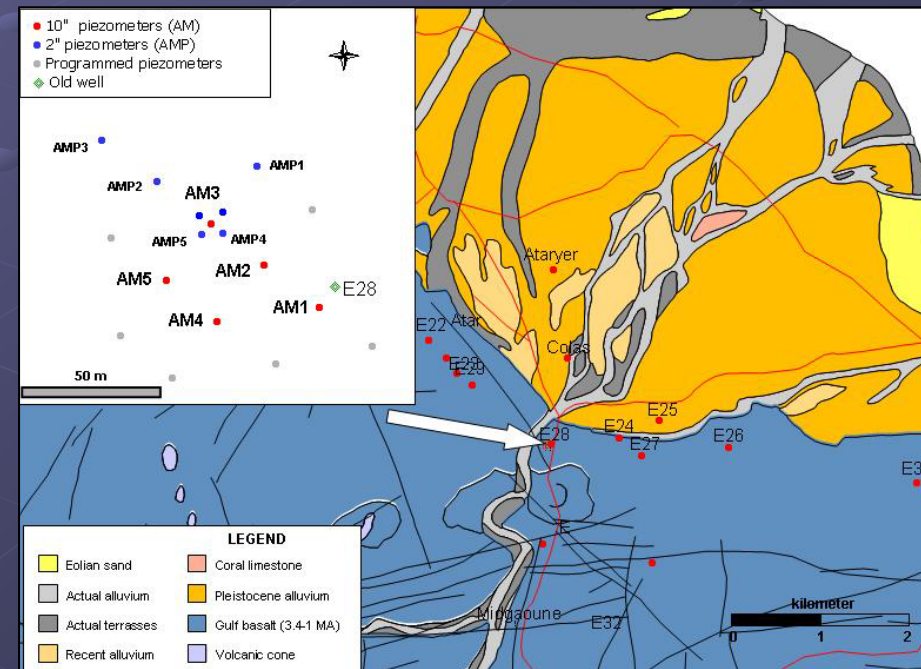
- Long term pumping tests on AM3 (4 piezometers)
- Complete slug tests on the AMP piezometers
- Address the fissured lava's permeability question
- Purchase automatic sampling equipments
- Different tracing techniques
- Piezometric map, periodic piezometric maps

## Modeling

- **Modeling of the Djibouti volcanic aquifer**  
underlying saline waters  
structures from geophysical surveys  
hydrodynamic-hydrochemical behaviour from monitoring  
hydrodynamic characteristics
- **Modeling of the aquifer at the HES**  
underlying saline waters  
structures from geophysical surveys  
hydrodynamic-hydrochemical behaviour from monitoring  
hydrodynamic characteristics  
recharge

# HES development

- **6 – 10 shallow depth drillings**  
 Enlarge the area of observation  
 HES hydrodynamic modeling purposes
- **Deep reconnaissance drilling in the HES: 100-150 m**  
 Aquifer system development  
 Hydrothermal minerals  
 Temperature gradient  
 Saline waters development  
 Origine of deep waters  
 Hydrodynamic characteristics



# PhD

## **Mohamed Daoud**

- **Université de Bretagne Occidentale**
- **Geology, geochemistry, tectonics**
- **Presentation: March 2008**

## **Abdourahman Houmed Gaba**

- **Université de Poitiers**
- **Hydrogeology, modeling**
- **Presentation programmed for end 2008**

## **Hassan Magareh**

- **Université de Bretagne Occidentale**
- **Applied geophysics**
- **Presentation programmed for 2009**

# Trainings

## Training of Djiboutians

- 2 or 3 technicians: Poitiers 2008, groundwater monitoring
- 1 hydrogeologist of MAEPH: Addis 2008, geochemical techniques
- 1 hydrogeologist of MAEPH: Nairobi 2009, vulnerability assessment

## Training of Ethiopian/Kenyan master degree students

- Geochemistry
- Groundwater hydrodynamics
- Modeling
- Geology

## Workshops

- **Hydrodynamic modeling. 2<sup>nd</sup> Workshop**
- **Tectonics and structural analysis**
- **Use of Djibouti aquifer model for MAEMH**

## International Symposium

- **International symposium in hydrogeology**

**Groundwater in volcanic rocks**

**End of 2008**

**Djibouti Government/Mawari project**

**IAH – IAHS – UNESCO - others**

## Ongoing scientific publications

- **First results at the HES: semi-unconfined behaviour of the basaltic aquifer. Jalludin M, Razack M, Abdourahman H.G. and Bouh H. (under submission to hydrogeology journal)**
- **Occurrence of a LREE-depleted component in the Afar plume: further evidence from recent basaltic lavas in the Djibouti rift. MA. Daoud, JA. Barrat, RC. Maury, RN. Taylor, B. Le Gall, H. Guillou, J. Rolet & J. Cotten. (manuscript sub-terminé, prévu à Lithos)**
- **Recent rift kinematics in the Tadjoura-Ghoubbet extensional linked system, West Gulf of Aden. MA. Daoud, B. Le Gall, RC. Maury, J. Rolet, & H. Guillou. (manuscript sub-terminé, prévu à Tectonics).**
- **Dynamics of initial rifting in the Afar Depression. The tectono-magmatic history of the Danakil and Ali Sabieh zones in the time period 3-30 Ma. B. Le Gall, MA. Daoud, J. Rolet, RC. Maury & H. Guillou. (manuscript en préparation, prévu à Journal of Structural Geology).**
- **Paleo-stress field during the Afar continental rifting. Evidence from the initial magmatic series in the Ali Sabieh zone. C. Sue, MA. Daoud, B. Le Gall, J. Rolet, & RC. Maury. (manuscript en préparation, prévu à Terra Nova).**
- **Petro-geochemical affinities of initial magmatism in the Afar rift. MA. Daoud, RC. Maury, JA. Barrat, B. Le Gall, H. Guillou, J. Rolet & J. Cotten.**
- **Hydrochemistry and environmental isotopes of HES, Eastern Afar rift. Bouh H, Travi Y., Jalludin M, Razack M, Abdourahman H.G. (in preparation for Hydrogeology Journal)**
- **MT on Djibouti aquifer. Tarits P, Hautot S, Hassan M**
- **Electrical tomography at the HES. Tarits P., Hautot S, Hassan M**

## Coming scientific publications

- **Modeling of the Djibouti volcanic aquifer**
- **Modeling of the Hydrogeological Experimental Site of Atar. Volcanic aquifer**
- **Recharge of a volcanic aquifer under arid climate**
- **Origine of the underlying high TDS waters in the Gulf basalts aquifer in Djibouti**
- **Djibouti volcanic aquifer structure based on modeling of electrical soundings**
- **etc...**

# Strengthening regional scientific partnership

## Strengthening regional scientific partnership

- Exchange of researchers and students on the ongoing works
- New specific scientific thematic based on available research results
  - hydrological budget
  - hydrodynamic characteristics of volcanic rocks
  - porosity and permeability of volcanic rocks
  - isotopes and geochemistry
  - fluoride data
  - mapping issues of aquifers
  - ...etc.
- Common scientific papers



## Outputs for a sustainable water resources management

- **Hydrogeological model of the Djibouti volcanic aquifer**  
Model provided to MAEMH and ONEAD
- **Groundwater management plan for the aquifer of Djibouti**
- **Vulnerability of the Djibouti aquifer**
- **Mapping of the saline water pockets of the Djibouti aquifer**



Thank you