Georesources & Environmental Management: toward a closed loop

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Since its birth 30 years ago, the Tunisian Association of Applied Geology (ATGA) has maintained a real dynamic of meetings and exchange among scientific actors in applied geology involving both local and international researchers. In the framework of its 6th Forum, ATGA organized The International Conference on Applied Geology & Environment (iCAGE 2016) held in Tunisia, May 2016.

Challenges arising from the implications of progressive economic development are threatening the whole ecosystem. This first International Conference on Applied Geology & Environment (iCAGE 2016) was dealing with earth sciences, including the pressing naturally occurring problems and management of natural resources. The conference offered a platform for active discussions regarding these real-time issues. Examining the current practices and determining the policies of the future endeavors occupied a prominent place in this conference. In fact, many critical challenges have been debated: environmental, scientific/technical, governance, health, and socio-economic challenges.

Indeed, ATGA was, as always, offering opportunities for researchers, juniors, and seniors to present their recent and most pertinent results. To emphasize the interest of partnership between academics, the main topics of iCAGE 2016 were built around few major concerns such as:

- Georesources (prospection and engineering tools; conventional and non-conventional resources; valorization, etc.)

- Geohazards and risk assessment (seismotectonics; landslides; floods and droughts; urban risk; civil security; risk assessment/management, etc.)
- Geomatics, GIS, and remote sensing (digital mapping; spatio-temporal modeling and analysis; GIS applications, etc.)
- Environment and sustainable development (water and soil management; waste management; coastal protection; mining/quarry sites planning, etc.)

As evidence of the rising interest, iCAGE 2016 received more than 400 participation with 364 papers presented as oral or poster during the meeting days. Our guests were from 40 different countries coming from Africa, Middle East, and Europe.

Following iCAGE 2016, this Special Issue (SI) of *Arabian Journal of Geosciences* (AJGS) is dedicated to present thirteen research papers, which fit into the scope of applied geology covering a broad range of disciplines dealing with the earth sciences linked to georesources and environmental management.

Three papers applied remote sensing, geoinformatics, and GIS in arid/semiarid climate for soil and/or water monitoring and assessment:

- Abbas et al. (2018) investigated the process of salt zonation (mineral composition and evolution in space and time) in Chott El Jerid, Tunisia, which is one of the largest endorheic basins in the world. Their research based on optical multisource, multispectral, multitemporal satellite data, and fieldwork revealed that evaporites precipitated as concentric layers (a relatively rare pattern) after several recent flooding events during the last 15 years. They also proved that a drop in reflectance in the short-wave infrared (SWIR) range caused by vibrations of the SO₄ group is an effective element for identifying sulfates such as gypsum.
- El Alaoui El Fels et al. (2017) modelled flood events in the semiarid areas of Rheraya watershed (Western High Atlas, Morocco) by a combination of mathematical and GIS-

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based approaches. Their algorithm gave satisfactory results for flood forecasting/prediction in such vulnerable areas, during a rainfall event.

- Jmal et al. (2017) assessed the groundwater vulnerability to nitrate pollution in Sidi Bouzid (Central Tunisia) shallow aquifer, using statistical approaches and GIS environment. The generated vulnerability map splits the study area into three vulnerability classes: low (32–99), moderate (100–139), and high (139–200), which cover 67, 20, and 13% of the study area, respectively, where the high vulnerability area coincides with the likelihood that nitrate concentration exceeds 24.5 mg/l in groundwater.

The applications of emergent tools for soil and rock characterization have been presented in the following two papers:

- Devarapalli et al. (2017) developed a comprehensive imaging protocol to characterize a dolomite rock from the microscale to the nanoscale. By combining both micro-X-ray tomography (micro-XCT) and focused ion beam coupled with scanning electron microscope (FIB–SEM), the different heterogeneities that exist in the carbonate (texture, mineralogy, pore size) have been accurately captured and identified. The reconstructed microporous structures were successfully used to predict elastic and permeability properties of selected carbonate.
- Trabelsi et al. (2018) studied the evaporation, shrinkage, and permeability behaviors on clayey soil originating from the region of Béja, northwest of Tunisia. They correlated the hygroscopic and mechanical parameters naturally modified during a desiccation process and they proposed some analytical models to describe clay behavior and to determine the intrinsic permeability using these parameters (moisture content, saturation degree, void ratio, etc.).

Two papers for valorizing natural or waste material in building and construction industry:

- Mosbahi et al. (2017) tested 70 mixtures of different local raw materials (clays limestone and sands) from the Mknassy-Mezzouna basin (Central Tunisia) for possible valorization in the manufacturing of hydraulic binder. The investigation and assessment of the mixtures allowed defining the adequate ratios and the necessary additives to make these natural reserves suitable in the clinker manufacture.
- Hajjou et al. (2017) successfully synthesized cordierite powder using 70% of fly ash (produced from coal combustion in thermal power plants) mixed with silica gel and magnesium chloride. The authors obtained pure indialite (α -cordierite) at 1300 °C and recommended the optimization of the sintering conditions for further valorization of fly ash in ceramics production.

In another paper, Akyol et al. (2017) optimized a microbially induced calcium carbonate precipitation (MICP) protocol to improve the engineering properties of sandy soil specimens. Selected bacteria (*Paenibacillus favisporus* U3) and optimized conditions (temperature, pH, urea concentration, incubation time, etc.) showed satisfactory results by enhancing the compressive strength and the young modulus of the treated samples up to 204.1 kPa and 89.4 MPa, respectively.

Azaza et al. (2017) provided an important insight into the scaling problem with calcium carbonate and barium sulfate, which causes flux decline and dangerous incidents in oil production facilities. They studied the effect of calcium ions on barium sulfate precipitation and investigated the effect of the formed BaSO_4 on calcium carbonate scale formation in synthetic $\text{Ca}(\text{HCO}_3)_2$ – BaSO_4 – NaCl aqueous system. Their experiments showed that added or formed barite in the reaction media is the main responsible agent to accelerate calcite precipitation.

In another context, two papers focused on landfill leachate treatment, where Kallel et al. (2017) applied electrocoagulation (EC) treatment with aluminum electrodes on autoclaved and raw landfill leachate. The proposed treatment enhanced the removal rate of COD to 64% and the nitrogen removal up to 30%. They also proved that sludge production drastically decreased from 40 to 10% of leachate-treated volume when the microorganisms are removed by autoclaving. Besides, the overall operating costs of leachate treatment would be significantly cut down by reducing the sludge handling and disposal operations. In another work, El Ouaer et al. (2017) highlighted the efficacy of microalgae strain (*Chlorella* sp.) isolated from a natural environment, in the treatment of landfill leachate. They showed the potential adaptation of *Chlorella* sp. and its contribution for treating landfill leachate organic contaminants. Besides, they recommended that the use of 10% of leachate could be a good alternative as a culture medium for *Chlorella* sp. growth.

The SI also includes a paper in which Chourabi et al. (2017) revealed that *Shigella flexneri*, a human pathogen, is capable of surviving lengthy periods under nutrient deprivation and results in increasing public health risks when discharged in water and soil.

In the last paper, Gaieb and Jallouli (2017) compiled 62 earthquake focal mechanisms from different seismic catalogs to constrain the present stress field of the Tunisian domain by using Frolich diagram and fault stress analysis. The neotectonic deformations highlighted the convergence between the African and European plates in a NW–SE direction, as confirmed by different approaches in several previous studies.

The future is certainly full of challenges for the whole ecosystem, our resources are really threatened and committed, and it is obvious that the solution is within a common approach and a real awareness of the danger at all levels (Kallel et al. 2020). We hope that this SI will offer AJGS readers a valuable opportunity to learn more about some georesources and environmental

management related topics, from exploration to valorization and remediation.

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