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**MINISTRE DE L'INDUSTRIE ET DES MINES
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BULLETIN ANALYTIQUE 2019

ENERGIE

1 : La Méditerranée orientale : subduction égéenne et héritage téthysien, enjeux énergétiques. Enjeux énergétiques et géopolitiques en Méditerranée. LEPARMENTIER F.

Mots-clés : Enjeux géopolitiques ; Enjeux énergétiques ; Pétrole; Gaz; Localisation; Commercialisation; Transit; Algérie; Méditerranée.

Résumé : Les enjeux géopolitiques du domaine méditerranéen sont indissociables des questions énergétiques liées aux hydrocarbures, aussi bien le pétrole que le gaz, avec trois composantes essentielles : la localisation des ressources, leurs voies de commercialisation et enfin leurs zones de transit, lorsque celles-ci sont acheminées depuis d'autres régions, en particulier le Moyen-Orient. La Méditerranée est le seul espace au monde où trois continents se rencontrent, avec 24 pays limitrophes représentant 7 % de la population mondiale et 8 % de la demande d'énergie primaire. Le poids économique de la partie européenne est prépondérant, représentant les trois-quarts du PIB de l'ensemble de la région. Quelques chiffres permettent de mesurer les enjeux des affrontements et alliances qui régissent les relations entre les différents protagonistes. L'Algérie, la Libye et l'Égypte détiennent à eux trois plus de 90 % des réserves d'hydrocarbures de l'espace méditerranéen et près de 5% des réserves d'hydrocarbures mondiales. L'Algérie est le troisième fournisseur de gaz de l'Union européenne, à hauteur de 12 % des importations, toutefois loin derrière la Russie et la Norvège. Un tiers des hydrocarbures commercialisés dans le monde transite par la Méditerranée ou ses pays limitrophes, le canal de Suez et le Bosphore étant les points de transit principaux vers les marchés européens.

L'espace politique et économique de la Méditerranée a été historiquement scindé en trois ensembles : les pays européens ; les pays de la rive sud (Afrique du Nord) ; les pays du Proche-Orient (Levant). Toutefois, les importantes découvertes de gaz réalisées à partir de 2009 dans l'offshore de la Méditerranée orientale et le regain d'intérêt qui en a découlé de la part des compagnies pétrolières pour le bassin du Levant ont amené à regrouper les pays d'Afrique du Nord et du Proche Orient dans un ensemble aux intérêts convergents, sous la dénomination de Pays du Sud et de l'Est de la Méditerranée (PSEM).

La Turquie occupe une place singulière. Sa position géographique, au carrefour des anciennes républiques soviétiques, du Moyen-Orient et de l'Europe, entre les pays producteurs à l'est et les pays consommateurs à l'ouest, lui confère un rôle stratégique majeur. Dépourvue de ressources significatives en hydrocarbures, elle tente de s'affirmer en tant que « hub » régional, véritable plaque tournante qui vise à capter au maximum les voies de transit que constituent les gazoducs et oléoducs.

Nous nous intéresserons plus particulièrement à la question de la Méditerranée orientale, car la mise en évidence, précédemment mentionnée, d'importants gisements gaziers depuis quelques années, a déplacé le point de focalisation stratégique de l'Afrique du Nord vers cette région.

In : Géochronique; n° 149, 2019, p. 54-57.

2 : Shale oil and gas exploration potential in the Tanezzuft Formation ,Ghadames Basin, North Africa. WANG Z., SHI B., WEN Z. , TONG X., SONG CH., HE Z., LIU X.

Keywords : Shale oil ; Shale gas ; Silurian source rock ; Hot shale ; Potential analysis ; Tanezzuft Formation ; Ghadames Basin ; North Africa.

Abstract : The Silurian Tanezzuft Formation 'hot shale' in North Africa is a high-quality source rock and a major contributor to the oil and gas reserves of the Paleozoic Ghadames Basin. This hot shale has similar sedimentary characteristics to those of the Silurian Longmaxi Formation shale in the Sichuan Basin in China, which is a proven prolific source of shale gas. In this study, the oil and gas accumulation conditions and sedimentary characteristics of the Tanezzuft shale are compared with those of the commercially exploited Longmaxi shale and the Marcellus and Barnett shales (North America), and criteria for shale oil and gas potential in the Tanezzuft shale are established from these commercially exploited shales. For the Tanezzuft shale, the net pay thickness of effective source rock, total organic carbon, thermal

maturity and burial depth, and the locations of faults in the Ghadames Basin are analyzed and mapped. The distributions of these variables are then used to predict the distribution of shale oil and gas with respect to the established criteria. It is shown that the Tanezzuft shale has significant potential for the production of shale and gas ; in particular, the northeastern and southwestern slopes of the Ghadames Basin are the most favorable in terms of prospective shale soil and gas exploration.

In : Journal of African Earth Sciences; vol. 153, 2019, p. 83-90.

GEOLOGIE STRUCTURALE

3 : Neotectonics and active tectonics of the Dahra-Lower Cheliff Basin (Tell Atlas, Algeria) : seismotectonic implication. ABOUDA M., MAUCHE S., BOUHADAD Y. , BELHAI D.

Keywords : Morpho-structural ; Neotectonic ; Folds and reverse fault ; Extradors faults ; Dahra ; Algeria.

Abstract : Neotectonics and active tectonics in the Dahra region (Northern Algeria) are investigated using morpho-structural analysis and field study. This work allowed us to identify several geological structures that exhibit characteristics of typical NE-SW active folds ; dissymmetric folds underlined by reverse faults with extradors normal faults. Five « en-echelon » structures were identified, namely, the Djebel Benzekri, the Djebel Semouda, the Abrevoir, the Bouassas and the Belhacel folds. The determined stress axis from field measurements is comparable to that derived from focal mechanisms solutions of recent earthquakes. The surveyed faults and folds are comparable to that known as seismogenic structures such as the Abou El Hassan and Oued Fodda fault-related folds reactivated during the 1922 (Mw= 6.0) and in 1980 (Ms = 7.3) destructive earthquakes, respectively. As results the offset and the slope determined for these structures could indicate an important rate of deformation. Using the obtained faults parameters the seismic potential is indicated by the capability of these structures to produce Mw > 6.0 earthquakes.

In : Journal of African Earth Sciences; vol. 153, 2019, p. 250-267.

4 : Relationship between fractures patterns and fold kinematics ; the case study of Jebel Sehib, a typical fault-propagation fold of southern Tunisia. AHMADI R., MERCIER E., TRIGUI H., OUALI J.A.

Keywords : Fracture/folding ; Fracture density ; Simple shear ; Pure shear ; Fault propagation fold ; Flexural slip ; Flexural flow ; Jebel Sehib ; Tunisia.

Abstract : Fracture patterns in folds are resulting from complex tectonic history. Indeed, in thrust and fold belts fractures occurred because of three different stress tensors : (1) regional field stress, (2) tensile stress in hinge area or (3) simple shear in limbs. Therefore, the same regional stress field could create too many different fracture and joint types. Detailed works have characterized fractures observed in nature, but only few studies have linked the fractures to the fold kinematics. On the other hand, we believe that fold kinematics have a key role in fracture amplitude and distribution. For this reason, we studied the fracture network affecting the Jebel Sehib, a typical fault-propagation fold of the Gafsa Basin, southern Tunisia. On the same bed, and all over fold parts, we measured the fracture net density. The results showed clear difference in fracture density spread with highest density in the forelimb, medium in the backlimb and lowest in the hinge area. Then, we compared the results with the theoretical kinematics of related fold/fracture models. We concluded that the fracture net is mainly anterior to the folding process. In fact, at the beginning of compressive stress, layer parallel shortening (LPS) occurred and generated homogenous fracture net in a pure shear regime attested by conjugated shear joints. During the growth of the fault-propagation fold, the existing fracture net is locally reactivated and amplified by limb simple shear as prospected in the mechanical behaviour of the fault-propagation fold. This leads to higher fracture density in the steeper flank. This hypothesis can be generalised to at least all fault-related folds in which limb simple shear is present. In the Jebel Sehib case study, we observed the flexural flow (internal deformation of the rock) because of the chosen massive limestone reference bed. In other natural examples, most of the beds accommodate simple shear by a flexural slip and rarely by flexural flow. This work have direct consequences on fractured reservoirs exploration in fault-related folds.

In : Journal of African Earth Sciences ; vol. 152, 2019, p. 23-35.

5 : Deformation pattern in the El Ahmar area (Bechar Basin, Southwestern Algeria) : contribution of Landsat 8 OLI and field measurement. CHABANE S., AMRI K., HAMDIDOUCHE R.

Keywords: Landsat 8 OLI; Principal component analysis; Geological and structural map; Tectonic phases; El Ahmar area; Bechar Basin; Algeria.

Abstract: El Ahmar-Boukaïs area is located in the Northern border of the Bechar Paleozoic Basin (Southwestern Algeria). The lack of structural studies in this area led us to undertake this study. The combination of field data and remote sensing analysis were used in order to highlight the Hercynian and Alpine deformations!:

in this area. For remote sensing, specific treatments (spectral enhancement, band ratios, principal component analysis, and directional filters) were applied to a Landsat 8 OLI (Operation Land Manager) image. Field measurement led us to validate the results. A mapping has value only with a field data collection. The results of the two approaches are similar, indicating a complementarity for better mapping. Four directions of tectonic structures are evidenced: N-S, NE-SW, E-W, and NW-SE; these directions are raked at least two different tectonic phases. The results issued from image processing techniques and field data were used to constrain the structural map where all tectonic structures are represented.

In: Arabian Journal of Geosciences ; vol. 12, n° 5, 2019, 158-12 p.

6: The Sidi Ifni transect across the rifted margin of Morocco (Central Atlantic) : vertical movements constrained by low-temperature thermochronology. CHARTON R., BERTOTTI G., ARANTEGUI A., BULOT L.

Keywords: Vertical movements ; Sidi Ifni transect ; Morocco ; Centra Atlantic.

Abstract : The occurrence of km-scale exhumations during syn- and post-rift stages has been documented along Atlantic continental margins, which are also characterised by basins undergoing substantial subsidence. The relationship between the exhuming and subsiding domains is poorly understood. In this study, we reconstruct the evolution of a 50 km long transect across the Moroccan rifted margin from the western Anti-Atlas to the Atlantic basin offshore the city of Sidi Ifni. Low-temperature thermochronology data from the Sidi Ifni area document a ca. 8 km exhumation between the Permian and the Early/Middle Jurassic. The related erosion fed sediments to the subsiding Mesozoic basin to the NW. Basement rocks along the transect were subsequently buried by 1-2 km between the Late Jurassic and the Early Cretaceous. From late Early/Late Cretaceous onwards, rocks present along the transect were exhumed to their present-day position.

In: Journal of African Earth Sciences ; vol. 141, 2018, p. 22-32.

7 : Thick-skinned tectonics in a Late Cretaceous-Neogene intracontinental belt (High Atlas Mountains, Morocco) : the flat-ramp fault control on basement shortening and cover folding. FEKKAK A., OUANAÏMI H., MICHARDA, SOULAIMANI A., ETTACHFINI E.M., BERRADA I., EL ARABI H., LAGNAOUI A., SADDIQI O.

Keywords: Intracontinental fold belt ; Thick-skinned tectonics ; Flat-ramp-flat faults ; Fault-propagation folds ; Late Cretaceous-Cenozoic ; High-Atlas ; Africa-Europe convergence.

Abstract : Most of the structural studies of the intracontinental High Atlas belt of Morocco have dealt with the central part of the belt, whose basement does not crop out. Here, we study the Alpine deformation of the North Subatlas zone, which is the part of the Western High Atlas (WHA) Paleozoic Massif that involves both Paleozoic basement units and remnants of their Mesozoic-Cenozoic cover formations. Our aim is to better constrain the geometry and kinematics of the basement faults during the Alpine shortening. Based on detail mapping, satellite imagery and field observations, we describe an array of sub-equatorial, transverse and oblique faults between the WHA Axial Zone and the Haouz Neogene basin. They define a mosaic of basement blocks pushed upon one another and upon the Haouz basement along the North Atlas Fault (NAF). The Axial Zone makes up the hanging-wall of the Adassil-Medinet Fault (AMF) South of this mosaic. The faults generally presents flat-ramp-flat geometry linked to the activation of multiple decollement levels, either within the basement where its foliation is subhorizontal or within favourable cover formations (Jurassic evaporites, Lower Cretaceous silty red beds, Upper Cretaceous evaporitic marls, Neogene basal argillites). The occurrence of the North Atlas detachment (NAD) allowed folded pop-up units to develop in front of the propagation NAF. Shortening began as early as the Campanian-Maastrichtian along the AMF. The direction of the maximum horizontal stress rotated from NNE-SSW to NNW-SSE from the Maastrichtian-Paleocene to the Neogene. The amount of shortening reaches 20% in the Azegour transect. This compares with the shortening amount published for the Central-Eastern High Atlas, suggesting that similar structures characterize the Paleozoic basement all along the belt. The WHA thick-skinned tectonics evokes that of the frontal Sevier belt and of the external Western Alps, although with a much minor pre-inversion burial.

In : Journal of African Earth Sciences ; vol. 140, 2018, p. 169-188.

8 : Tectonics-mineralisation relationships within weak continental lithospheres : a new structural framework for Precambrian cratons. GAPAIS D.

Keywords : Tectonics; Precambrian; Weak lithospheres; Crustal shortening; Mineralisation.

Abstract : Many Archaean and Paleoproterozoic cratons show deformation patterns that differ from those observed in modern orogens. On the other hand, they constitute an important part of present-day emerged continents and contain a large part of continental mineral resources known to date. On the basis of a summary of structural data from some typical field examples and of results of analogue modelling, we emphasize that pop-down tectonics marked by vertical burial of supracrustals within an underlying hot and weak crust may be the most suitable model to account for deformation patterns of many ancient deformation zones. An overview of relationships between structural patterns and mineralisation in several ancient deformation zones further emphasizes that pop-down tectonics provides a very promising structural framework for mining exploration in Precambrian cratons.

In : Bull. Soc. Géol. France – Earth Sciences Bulletin; t. 189, n° 3, 2018, 14-11 p.

9 : Evolution of E-W strike-slip fault network, the northwestern foreland of Tunisia. HAMDY M.S., SOUMAYAA, KADRI A., BEN AYED N., BRAHAM A., SHIMI N.

Keywords : E-W basement faults ; Pre-existing faults ; Diapirs ; Riedel shear type faults ; Folds ; Tectonic inversion ; Tunisia

Abstract : The northwestern foreland of Tunisia (El Kef region and its surroundings) is a key area to study the tectonics of main E-W basement strike-slip faults and related structures. To achieve this goal, we used multidisciplinary approaches including field work, paleo-stress analyses and geophysical data. These approaches allowed us to propose a new structural model based on the evolution in space and time of Riedel shear type faults and to highlight their role in the structuring of the study region. During the Mesozoic, E-W normal oblique-slip basement faults (D1 : Ghardimaou fault, D2 : EL Kef-Ouergha fault, D3 : Jebel Harraba-Guern Halfaya fault and D4 : Tajerouine fault) controlled the architecture and the subsidence of the El Kef Basin within a transtensive setting by block tilting, NE-SW negative flower structures, Triassic salt ascent and deposits thicknesses and facies variations. During the Eocene and Late Miocene, the NW-SE shortening (tectonic inversion) is expressed by the oblique reactivation of the pre-existing E-W faults as dextral strike-slip faults. This reactivation is accompanied by map-scale Riedel shear type faults, where D1, D2, D3 and D4 formed the principal displacement zones (PDZs). The successive movements of these faults cut the study area in several right-lateral shear bands in which subsidiary Riedel fractures (R, R', X, P, T and Y) and NE-SW folds are developed. Fault slip data and fractures analyses, across the study area, show several fracture systems which interact under a NW-SE SH_{max} . During Quaternary, the NNW-SSE shortening reactivated the pre-existing E-W fault networks (PDZs). It also, formed N-S left-lateral strike-slip faults, NW-SE grabens, NE-SW reverse faults, and ENE en echelon folds arranged within Riedel shear bands.

In : Journal of African Earth Sciences; vol. 153, 2019, p. 278-290.

10 : Constrasting Pan-African structural styles at the NW margin of the Congo shield in Cameroon. KANKEU B., GREILING R.O., NZENTI J.-P., GANNO S., DANGUENE P.Y.E., BASSAHAK J., HELL J.V.

Keywords : Magnetic fabrics (AMS); Wrench tectonics; Central African Fold Belt (CAFB); Congo shield; Pan-African thrust margin ; West Gondwana.

Abstract : Field, microstructural, and anisotropy of magnetic susceptibility (AMS, magnetic fabrics) studies assessed the Pan-African deformational history and strain geometry at the Southern margin of the Central African Fold Belt (CAFB) against the older, cratonic basement of the Congo Shield (CS). Reflected light microscopy and thermomagnetic studies supported the identification of magnetic minerals. Data cover a low angle thrust margin (Mbengis-Sangmelima area) in the East and high angle shear zones cutting the margin (Kribi area) in the West, at the Atlantic Coast. In the CS basement units, magnetic anisotropy is generally higher than in the low grade Pan-African units. In the latter, early D₁/D₂ shortening produced a flat-lying magnetic foliation parallel with the regional trend of the belt, a shallow magnetic lineation, and mostly oblate fabrics. Subsequent D₃ deformation is only of local importance in the Mbengis-Sangmelima area. The magnetic lineation shows distinct maxima in NNE-SSW direction, parallel with the low angle tectonic transport direction. In the Kribi area, the NNE-SSW trending Kribi-Campo shear zone (KCSZ) affected both older rocks and Pan-African high grade metapelites of the Yaoundé unit together with their basal thrust. The early planar fabric (S₁) was overprinted during D₂ folding under relatively high T conditions, and subsequent D₃ wrenching. Magnetic fabrics document a progressive change from oblate towards prolate ellipsoids towards the KCSZ. Magnetic foliations with medium to steep

dips curve into the N-S to NE-SW orientation of the KCSZ, lineations follow the same trend with shallow to medium plunges. This fabric implies that the KCSZ is a Pan-African strike-slip shear zone with a subordinate component of compression. Strike-slip tectonics in the west (KCSZ) and thrusting in the east imply N-S to NE-SW convergence during Pan-African terrane assembly against the present northern margin of the CS. In addition, the KCSZ may separate the CS from the Sao Francisco Craton in Brazil and thus be the northern part of a link connecting the CAFB to the West Congo Belt in the south. This putative Pan-African link separated the Sao Francisco Craton from the Congo Shield prior to Mesozoic Gondwana break-up.

In : Journal of African Earth Sciences ; vol. 146, 2018, p. 28-47.

11 : Géodynamique de la Méditerranée occidentale : une série de bassins d'arrière-arc dans un environnement montagneux. La chaîne tello-rifaine (Maroc, Algérie, Tunisie) de la fin du Crétacé à l'Actuel : une linéarité en trompe-l'œil. LEPRÉTRE R., DE LAMOTTE D., DEVERCHERE J., GRAINDORGE D.

Mots-clés : Géodynamique ; Découpage structural ; Structuration ; Cinématique ; Chaîne tello-rifaine; Algérie ; Tunisie ; Maroc.

Résumé : Le long de la bordure sud de la Méditerranée occidentale s'étire la chaîne tello-rifaine. Le Tell se développe de la Tunisie jusqu'à la frontière algéro-marocaine où il se trouve alors relayé par la virgation orogénique formée par le Rif qui se prolonge *via* le détroit de Gibraltar dans la chaîne des Bétiques en Espagne. Le parti pris de cette contribution est de présenter et décrire ensemble Tell et Rif, à l'encontre d'une habitude qui veut que le Rif soit le pendant des Bétiques côté africain. Un récent réexamen de la géologie des zones externes du Tell et du Rif a permis d'illustrer à quel point, à la linéarité de l'édifice orogénique nord-maghrébin, se superpose une non-cylindricité de la chaîne (*i.e.* qu'il existe des variations latérales avec présence/absence de certaines grandes unités géologiques impliquées dans la chaîne). Cette contribution propose d'éclairer et d'illustrer cet aspect fondamental, qui résulte à la fois d'un héritage téthysien complexe et d'une structuration précoce au Paléogène avant les révolutions cinématiques de l'Oligo-Miocène.

In : Géochronique ; n° 149, 2018, p. 26-34.

12 : Structural styles, tectonic events, and deformation features along a surface-subsurface structural transect from the South Atlas Front (N-S axis) to the Eastern Sahel foreland basin of Tunisia. MEZNI R., KHOMSI S., BEDIR M.

Keywords: E-W inverted structures; N-S axis seismic sections; Detachment folds; Thick-skinned tectonics; Balanced cross-section; Restored sections; Eastern Tunisia.

Abstract : 2D seismic cross-sections calibrated to exploration wells allow highlighting the structural styles along a structural transect from the N-S axis, west of the Bouthadi-Chorbane anticline to the foreland, with a major regional tectonic anomaly striking roughly E-W along the subsurface Atlas front of the foreland basin.

The interpretation of structural data and seismic profiles allow deciphering clearly the occurrence of Late Cretaceous-Paleogene inversion structures, accounting for folds detached along the basal intra-Triassic salt decollement level. These contractional structures in part result from the Middle-Late Eocene compressional events, which induced the first strong positive inversion in both the Atlas domain and adjacent foreland. The growth of these positive structures is outlined by angular unconformities, sedimentary gaps, and differential subsidence within the Paleogene deposits.

The foreland area is characterized by a thick-skinned tectonic inversion style, where the Pre-Triassic basement is decoupled from its Jurassic-Quaternary sedimentary cover by a general decollement level located at the Upper Triassic/Lower Jurassic interface. The deformation features imaged by seismic sections are in agreement with such thick-skinned style controlled by deep-seated faults presumably inherited from the Pan-African basement.

A regional structural cross-section is presented and discussed, crossing the N-S axis and outcrops of the South Atlas Front in the west and, then, running through the major structural anomaly of Chorbane and the foreland basin to the east. This regional cross-section has been also balanced and restored to its initial and intermediate geometries, *i.e.*, after the Tethyan and Cretaceous extensional events and Paleogene compressional events, thus documenting the major tectonic anomaly of Bouthadi-Chorbane in the foreland as well as the overall structural evolution of the Atlas fold and thrust belt.

In : Arabian Journal of Geosciences ; vol. 12, n° 6, 2019, 186-17 p.

13 : Liassic age of an oceanic gabbro of the External Rif (Morocco) : implications for the Jurassic continent-ocean boundary of Northwest Africa. MICHARD A., MOKHTARI A., LACH PH., ROSSI PH., CHALOUAN A., SADDIQI O., RJIMATI E.-CH.

Keywords : Transform zone ; Gibraltar arc ; Alpine Tethys ; Central Atlantic ; West African continental margin.

Abstract : This work concerns the northernmost limit of the West African Craton (WAC) and Variscan WAC-related terranes of NW Africa. Based on newly obtained radiometric age of an oceanic gabbro from the « Mesorif suture zone » of the External Rif Belt, we propose a revised interpretation of this puzzling lineament. We report on a 190 ± 2 Ma LA-ICP-MSU-Pb zircon age of a trondhjemite vein cross-cutting the Bou Adel gabbro, which is one of the largest oceanic units of the quoted suture zone. We previously interpreted the arcuate MSZ in terms of transported, hyper-extended margin of the Alpine Tethys, based on a K-Ar ± 166 3Ma age ascribed to the Bou Adel gabbro in the literature. The new, Early Middle Liassic age coincides instead with the onset of oceanic floor formation in the Central Atlantic. We hypothesize that the Mesorif suture zone corresponds to the transported trace of the West African Atlantic margin surrounding the northwestern Moroccan Meseta promontory and connecting with the ENE-trending North African Transform. The latter zone sharply bounded the North Africa margin and connected the Central Atlantic with the Alpine Tethys. We propose that transported elements from the North African transform constitute the 'Mesorif Basalt-Breccias' lineament parallel to and more external than the Mesorif suture zone. If correct, this new interpretation provides an opportunity to develop detailed field and laboratory studies of an exhumed segment of the up-to-now conceptual Jurassic North African transform.

In : C. R. Acad. Geoscience ; vol. 350, n° 6, 2018, p. 299-309.

14 : Hydrothermal alteration mapping and structural features in the Guelma basin (Northeastern Algeria) : contribution of Landsat-8 data. NAIT AMARA B., AISSA DJ.E., MAOUCHE S., BRAHAM M., MACHANE DJ., GUESSOUM N.

Keywords: Remote sensing (Landsat-8 data); Alteration mapping; Mineralization; Lineament; Guelma basin; Algeria.

Abstract : In this work, we use remote sensing tools to recognize and map outcrops of altered hydrothermal rock zones in the Guelma basin (Northeastern Algeria). This basin is characterized by many thermal springs which could be the origin of the hydrothermal alterations and the source of polymetallic mineralization of Zn, Sb, Pb, and As. Structural lineaments representing faults or faulted zones were successfully extracted using sensing processing. The superimposition of the known mineralization site map with the evidenced lineaments and hydrothermal alteration zones evidences that the zones of high fractures density and of great structural complexity are in agreement with the detected hydrothermal alterations zones.

In : Arabian Journal of Geosciences ; vol. 12, n° 3, 2019, 94-14 p.

15 : Relationships between structural lineaments and Cenozoic volcanism, Tibesti swell, Saharan metacraton. NKONOC., LIEGEOIS J.-P., DEMAIFED.

Keywords : Cenozoic volcanism ; Lineaments ; Metacraton ; SRTM DEM images ; Tibesti ; Africa-Europe convergence.

Abstract : This work reports an analysis of the relationships existing between the structural lineaments and the Cenozoic volcanism of the Tibesti area (northern Chad). Shield volcanoes, cinder cones, structural lineaments, intersection points of lineaments and faults are mapped using the combination of Shuttle Radar Topography Mission (SRTM), Digital Elevation Models (DEMs) and Landsat satellite images of the Tibesti Volcanic Province. The interpretation of the distribution of these structural and morphological features allows constraining the structural/tectonic setting of the Tibesti. We show that the relationships between the lineaments and the volcanic centres of the Tibesti province can locally be explained as the result of the combination of two Riedel dextral tectonic systems, respectively oriented at N120°E and N30-35°E. Taking into account the geological features of the area, a geodynamical model is proposed : the emplacement of the Tibesti Volcanic Province results from the reactivation of inherited structures of the Saharan metacraton, characterized by relict rigid cratonic nuclei and metacratonic areas reworked during the Pan-African orogeny, among which is located the Tibesti. The contrasted behaviour of these rheologically different zones can explain the location and the evolution of the Tibesti swell and volcanism. The new data presented in this paper and their interpretation in terms of the emplacement of the Tibesti volcanic province in the Saharan metacraton bring a new and major information about the behaviour of the African plate within its collisional context with Europe.

In : Journal of African Earth Sciences ; vol. 145, 2018, p. 274-283.

16 : Unraveling a distal segment of the West African Craton Paleozoic margin : stratigraphy of the Mougueur inlier of the eastern High Atlas, Morocco. OUANAIMI H., SOULAIMANI A., BAIDDER L., EDDEBBI A., HOEPFFNER CH.

Keywords : Variscan belt ; Paleozoic ; High Atlas ; Anti-Atlas ; Gondwana.

Abstract : Because of its location in the boundary zone between the Anti-Atlas and the Atlas-Meseta crustal domains of Morocco, the Mougueur Paleozoic Massif is a key area to decipher the evolution of the Gondwana NW margin during the Paleozoic. In this work, we report for the first time the occurrence of Hirnantian sandstones, Silurian (Gorstian) graptolitic shales and probable Lower Devonian turbidites in the Massif. Comparison of our observations with regional stratigraphic data from literature allows us to suggest that the area was included in the distal part of the West African Craton passive margin during Cambrian-Devonian times.

In : C. R. Acad. Geoscience; vol. 350, n° 6, 2018, p. 289-298.

17: Superposed tectonic regimes in west Beni Suef basin, Nile Valley, Egypt: implications to source rock maturation and hydrocarbon entrapment. SAKRAN SH., SHEHATA A.A., OSMAN O., EL-SHERBINY M.

Keywords : Tectonic regimes ; Strike slip tectonics and growth folds ; Kinematic evolution ; Source rock maturation and entrapment styles ; West Beni Suef Basin ; Nile Valley ; Egypt.

Abstract : The present study contributes to the knowledge of the structural architecture and kinematic evolution of the West Beni Suef basin, by means of detailed seismic interpretation. This basin is one of several in a NW-SE oriented Early Cretaceous basin system occurring at the northeast corner of the African plate. We used the patterns of growth sedimentation above the limbs of growth folds, and in the downthrows of normal faults as kinematic indicators. Two phases of strike slip tectonics during the Santonian and Campanian-Maastrichtian superposing an Early Cretaceous rifting are verified in this basin. The Santonian and Campanian-Maastrichtian strike slip tectonics are represented by an E-W strike slip fault zone associated with NE growth folds and NW growth normal faults as well as ENE, WNW and E-W strike slip fault segments. The Early Cretaceous rifting facilitates the maturation of the deeper source rocks such as Lower Cretaceous shales of the Kharita Formation. Moreover, the strike slip tectonic events played a major role in the maturation of the shallow depth Cenomanian-Turonian Abu Roash « F » Member through entrapment in a releasing bend at the central part of the study area. The structures associated with the two tectonic regimes include, horsts, normal fault propagation folds and strike slip related anticlines, which formulated the main structural traps in the study area.

In : Journal of African Earth Sciences ; vol. 154, 2019, p. 1-19.

18 : Distinguishing rift-related from inversion-related anticlines : observations from the Abu Gharadig and Gindi Basins, Western Desert, Egypt. SARHAN M.A., COLLIER R.E.

Keywords : Anticlines ; Rifting ; Inversion tectonics ; Gindi Basin ; Abu Gharadig Basin ; Western Desert ; Egypt.

Abstract : Distinguishing the tectonic origin of anticlinal structures is problematic in regions with a complex history of rifting and inversion. We present the results of seismic mapping, in the form of time-depth (isochron) and time-thickness maps to characterize how sedimentary thickness differentials evolved in response to normal faulting and to inversion events on faults within the Abu Gharadig and Gindi Basins in the Western Desert of Egypt. Late Cretaceous rift-related faults in the Abu Gharadig Basin strike NW-SE, W-E and SW-NE. In the eastern part of the basin, a prominent SW-NE trending interbasinal saddle formed in response to preferential subsidence forming half-grabens to its north-west and southeast, during the Mid-Turonian to Santonian interval. Santonian to Palaeogene inversion in the Abu Gharadig Basin developed on its northern basin margin, the absence of SW-NE striking faults in the eastern central basin resulting in any inversion effects being minor. In the central Gindi Basin, Upper Cenomanian to Lower Turonian SW-NE striking rift faults underwent inversion as early as the Mid-Turonian. The orientation of existing rift faults and modification of the local stress fields control the extent to which inversion was taken up in each basin trough time. The Abu Gharadig and Gindi Basins are two of the rift basins developed in West and Central Africa that underwent rifting, inversion and dextral shearing during the Late Cretaceous. We emphasize the value of high-resolution stratigraphic mapping to characterize short-lived and subtle pop-up events that may have gone unnoticed.

In ; Journal of African Earth Sciences ; vol. 145, 2018, p. 234-245.

19 : The Anti-Atlas Pan-African belt (Morocco) : overview and pending questions. SOULAIMANI A., OUANAIMI H., SADDIQUI O., BAIDDER L., MICHARD A.

Keywords : Paleoproterozoic ; Neoproterozoic ; Collision belt ; Eburnian ; Post-collisional magmatism ; Anti-Atlas ; Morocco ; Pan-African.

Abstract : Between the High Atlas and the Saharan platform, the Anti-Atlas of Morocco offers large exposures of Precambrian rocks beneath the moderately folded Paleozoic series. These inliers allow reconstructing a segment of the Pan-African Belt and of its foreland at the northern outskirts of the West African Craton (WAC). From ~ 885 Ma to ~ 540 Ma, three periods are recognized in the Pan-African cycle. The Tonian-Cryogenian period ends with the obduction of supra-subduction ophiolite and oceanic arc material at ~ 640 Ma. The Early Ediacaran period is marked by the development and subsequent closure of a wide marginal basin next to a likely Andean-type arc. The Late Ediacaran period is recorded by subaerial molasse deposits associated with post-collisional high-K calc-alkaline to shoshonitic magmatism. Although a wide consensus has been reached based on the number of new robust datings, several questions still remain pending, which we address taking into account relevant African and European correlations.

In : C. R. Acad. Geoscience ; vol. 250, n° 6, 2018, p. 279-288.

20 : La Méditerranée orientale : subduction égéenne et héritage téthysien, enjeux énergétiques. Les reliques téthysiennes en Méditerranée orientale : les bassins Ionien, d'Hérodote et du Levant. TUGEND J., CHAMOT-ROOKEN, SAPINF., ARSENIKOS S., BLANPIED C., FRIZON DE LAMOTTE D.

Mots-clés : Subduction égéenne ; Rif ; Age ; Evolution ; Structure ; Bassin Ionien ; Marge ; Hérodote ; Levant ; Tethys ; Méditerranée.

Résumé : La Méditerranée orientale préserve les traces d'épisodes successifs de rifting, marqueurs de l'évolution polyphasée de la marge sud téthysienne au cours du Paléozoïque, du Mésozoïque et du Cénozoïque. Mais lequel de ces épisodes a mené à l'ouverture des bassins profonds de la Méditerranée orientale ? Les événements tectoniques majeurs invoqués sont classiquement attribués soit directement à la formation de l'océan Néo-Téthys au cours du Permien, soit au développement d'une branche secondaire plus tardive qui se serait individualisée au cours du Trias supérieur-Jurassique inférieur ou même depuis la fin du Jurassique jusqu'au Crétacé. Selon l'âge de formation considéré, deux directions d'extension orthogonales sont proposées, une ouverture NE-SO ou NO-SE. Ainsi, la formation, l'évolution et la structure actuelle des bassins de la Méditerranée orientale représentant les reliques de la Téthys restent largement débattues. Ces reliques représentées par les bassins Ionien, d'Hérodote et du Levant sont caractérisées par une croûte mince (<10 km d'épaisseur) dont la nature continentale ou océanique reste incertaine. Ces bassins sont caractérisés par des séquences sédimentaires importantes dont l'épaisseur cumulée peut dépasser 10 km, recouvertes en partie par les prismes sédimentaires calabrais et la Ride méditerranéenne développés depuis le Miocène face aux arcs calabrais helléniques. Si les nombreux travaux précédemment menés ont permis de cartographier les séquences les plus récentes et superficielles, les plus profondes ne sont que peu corrélées à l'échelle des bassins. La calibration de ces séquences et leur corrélation à l'échelle des bassins apparaît comme essentielle afin d'améliorer notre connaissance du contexte tectonique et stratigraphique de la Méditerranée orientale.

In : Géochronique ; n° 149, 2018, p. 48-54.

STRATIGRAPHIE

21 : New chronostratigraphic constraints on the emplacement of Miocene high-K calc-alkaline igneous rocks from West Edough-Cap de Fer, NE Algeria. ABBASSENE F., CHAZOT G., BELLON H., MAURY R.C., COURME-RAULT M.-D., OUABADI A., COUTELLE A.

Keywords: Geochemistry; Post-collisional magmatism; K-Ar geochronology; Biochronology; Miocene; Eastern Algeria.

Abstract : Miocene K-rich calc-alkaline magmatic rocks are exposed over a ~150 km² area in Cap de Fer and West Edough, along the NE Algerian Mediterranean coast. They include andesitic pyroclastic and lava flows, small dioritic plutons, and large microgranodioritic intrusions that intrude and/or overlie Miocene sediments. New ⁴⁰K-⁴⁰Ar ages obtained on the igneous rocks range from 16.84 ± 0.58 to 12.91 ± 0.31 Ma and define three successive magmatic pulses at ~16.5, ~15, and ~13 Ma. These data are in good agreement with biostratigraphic data obtained on the Miocene marls

that yielded Langhian (N8 biozone) to Late Langhian-Serravallian ages (N9-N10 biozones). This consistency suggests that the time span (~3.5 m.y.) deduced from K-Ar datings is not due to perturbations of the K-Ar clock ; it is more likely related to long-lasting tectono-magmatic processes. According to the regional context (« no-slab » area), these processes result from the uprise of hot asthenospheric mantle through the tear generated by the detachment of the oceanic part of the African slab beneath the Algerian margin that triggered the partial melting of the overlying metasomatized lithospheric mantle of the Kabyliides.

In : Arabian Journal of Geosciences ; vol. 12, n° 2, 2019, 22-19 p.

22: Chemostratigraphy of Late Sinemurian- Early Pliensbachian shallow-to deep-water deposits of the Central High Atlas Basin: paleoenvironmental implications. DANISCH J., KABIRI L., NUTZ A., BODIN S.

Keywords : Early Jurassic ; Neritic carbonates ; Organic carbon isotopes ; Carbon cycle perturbation ; Morocco.

Abstract : Shallow water carbonate rocks are especially prone to diagenetic alteration. As such they are sometimes problematic archives of past carbon cycle perturbations, casting doubt on the reliability of shallow-water carbonates carbon isotopes analyses for chemostratigraphic purposes. In this paper, bulk organic carbon isotopes ($\delta^{13}\text{C}_{\text{org}}$) is used as a robust replacement of the more sensitive carbonate carbon isotope systems for the establishment of a refined chronostratigraphic framework for the evolution of Sinemurian-Pliensbachian neritic carbonate systems in the Central High Atlas Basin of Morocco. These data show very similar patterns and characteristics in the organic carbon isotope curves of basinal and platform sections and thus illustrate the reliability of these archives. Simultaneously, we explore the expression of the global carbon isotope excursion at the Sinemurian-Pliensbachian boundary (S-P event) in the study area in Morocco. This event has been previously described as a negative carbon isotope excursion of ~ 2‰ associated with a large transgression in numerous basins. In Morocco and other neritic carbonate records, the S-P event is better described as a return to previous values after a positive carbon isotope excursion coinciding with a major latest Sinemurian regression recognised on a global scale. Similar patterns are also found in other sections, although sometimes poorly expressed. However, it shows, that the S-P event has ambiguous characteristics and questions the conventional hypothesis of it being linked to the massive injection of ^{13}C -depleted carbon into the atmosphere-ocean system.

In : Journal of African Earth Sciences ; vol. 153, 2019, p. 239-249.

23: A review of the latest Cenomanian to Maastrichtian geological evolution of Nigeria and its stratigraphic and paleogeographic implications. EDEGBAI A.J., SCHWARK L., OBOH-IKUENOBE F.E.

Keywords : Upper Cretaceous ; Mineral resources ; Petroleum potential ; Trans-Saharan seaway ; Benue Trough ; Nigeria.

Abstract : This contribution presents a comprehensive review of the Upper Cretaceous geological evolution of Nigeria focusing on the Benue Trough and adjacent basins. It addresses the controversies regarding potential pathways of ingression during transgressive episodes that led to the establishment of the *Trans*-Saharian seaway. An improved understanding of the paleogeographic evolution is essential for assessing the economic potential of the region, including the Upper Cretaceous petroleum system and coal deposits, as well as groundwater and mineral resources. Two transgressive episodes connected much of Nigeria's sedimentary terrain in the Upper Cretaceous. The first transgression, which followed the opening of the Equatorial Atlantic Ocean in mid-Albian times, established the *Trans*-Saharan seaway that connected the Tethys and the South Atlantic Oceans through an eastward route via the Benue Trough in the Turonian. This resulted in widespread deposition of commercially exploited marine limestone and clay deposits, and subordinate coal, with sediments possessing very limited groundwater resource potential. This marine connection ceased with the continent-wide Santonian inversion tectonics that led to folding , faulting , uplift , and intrusion of older strata . A second transgression, commencing in the Campanian, reestablished the *Trans*-Saharan seaway through a westward Bida Basin route in the Maastrichtian, culminating in widespread, mostly marginally marine conditions in the Sokoto, Bida, Anambra, and Benin basins as confirmed in this review. The influx of marine waters from the Tethys Ocean, limited in extent by the uplifted region of the southern Benue Trough brought about marginally marine conditions in the Chad Basin and the northern and central Benue Trough. Widespread deposition of coal, clay, ironstone, and good to prolific aquiferous units occurred during this time.

In : Journal of African Earth Sciences ; vol. 150, 2019, p. 823-837.

24 : Middle Eocene to early Oligocene dinoflagellate cyst biostratigraphy and paleoenvironmental interpretations of the Ben Attaya section at Taza, eastern External Rif, Morocco. MAHBOUB I., SLIMANI H., TOUFIQ A., CHEKAR M., DJEYA K.L., JBARI H., CHAKIR S.

Keywords : Bartonian-Rupelian ; Dinocyst stratigraphy ; Paleoenvironment ; External Rif ; Southern Mediterranean ; Ben Attaya ; Taza ; Morocco.

Abstract : The palynological study was carried out on middle Eocene to early Oligocene sediments from the Ben Aattaya section, located in the Taza region, eastern External Rif, northeastern Morocco. The palynological content is dominated by dinoflagellate cysts (dinocyst), while spores and pollen are rare. Very known dinocyst event markers were used for dating the Ben Attaya section. The first occurrences (FO) of *Cerebrocysta bartonensis*, *Glaphyrocysta semitecta*, *Lentinia serrata*, *Operculodinium divergens* indicate the Bartonian. The FOs of *Deflandrea heterophyr*, *Schematophora speciosa*, *Stoveracysta ornata* were used to recognize the Priabonian. While the Fos of *Chiropteridium lobospinosum* and *Wetzeliella gochtii*, as well as the last occurrences (LO) of *Achilleodinium biformoides*, *Charlesdowniea coleothrypta* subsp. *Coleothrypta*, *Enneadocysta pectiniformis*, *Glaphyrocyst semitecta*, *Hemiplacophora semilunifera*, *Lentinia serrata*, *Operculodinium divergens*, *Rhombodinium perforatum*, *Schematophora speciosa* and *Stoverocysta ornata* highlight the Rupelian. The changes in relative abundances of selected dinocyst groups and sporomorphs (pollen and spores) suggest a lagoonal to coastal inner neritic marine environment during the Bartonian and Priabonian, which was interrupted by a short phase of outer neritic conditions at the basal part of the section and ended by a marked decrease in the sea level, probably due to a regression during the Priabonian. The Rupelian deposits indicate a middle neritic marine environment marked by a progressive rise during the transgression.

In : *Journal of African Earth Sciences* ; vol. 149, 2019, p. 154-169.

25 : Cenomanian-Turonian depositional history of a post-Gondwana rift succession in the West Beni Suef Basin, Egypt. SHEHATA A.A., EL FAWAL F.M., ITO M., ABDEL AAL M.H., SARHAN M.A.

Keywords : Sequence stratigraphic evolution ; Cenomanian-Turonian depositional evolution ; Post-Gondwana rift ; West Beni Suef Basin ; Egypt.

Abstract : The structural and stratigraphic evolution of rift basins has been documented globally from modern systems, outcrop and subsurface datasets. Extensive fragmentation and break-up of Gondwana during the Cretaceous created a complex suite of rift basins in the Northern Africa. The Beni Suef rift basin straddles the River Nile and is infilled by a thick Mesozoic-Tertiary succession. Cenomanian-Turonian deposition commenced with the sandstone-dominated Bahariya Formation. Depositional environments transitioned stratigraphically from fluvial marine to shallow marine and finally to mixed clastic and non-clastic shelfal deposits of the Abu Roash Formation. Sedimentation styles were tectonically controlled showing transgressive-to-regressive depositional cycles developed over the Gondwana rift systems. Cycles were controlled by short-lived, small-scale tectonic oscillations of the platform, resulting in four depositional sequences. Deposition environments in the Cenomanian transitioned from shallow marine to deeper marine shelfal deposits and finally to a coastal environment. During Late Cenomanian-Early Turonian, rapid platform submergence resulted in a transgressive facies succession, topped by deltaic deposits. In the Middle-Upper Turonian, two sequences formed with an intervening short-lived period of lower relative sea level. Relative sea-level oscillations were partly in phase with the global sea-level changes, controlled by local tectonics induced by the fragmentation of Gondwana during the Late Cretaceous.

In : *Journal of African Earth Sciences*; vol. 150, 2019, p. 783-798.

SEDIMENTOLOGIE

26 : Depositional environments and sequence stratigraphy of a mixed siliciclastic-carbonate ramp: an example from the Cenomanian to Turonian Galala formation in the northern Eastern Desert, Egypt. ABDEL-FATTAH ZA., KORA M.A., RAAFAT S.A.

Keywords : Facies analysis; Cenomanian-Turonian; Paleoenvironments; Sequence stratigraphy; Ramp; Egypt.

Abstract : Sedimentologic, stratigraphic and ichnological data are integrated to develop a model linking base-level changes to depositional evolution of a mixed siliciclastic-carbonate ramp. Two consecutive depositional stages are suggested for interpreting architectural development of the reported five siliciclastic facies associations (FA1 to FA5) and

six carbonate facies types (FT1 to FT6) in the Galala Formation. The Late Cenomanian siliciclastic-dominated stage shows offshore transition and shoreface siliciclastic succession, in addition to lagoonal coastal plain deposits. The Late Cenomanian to Early Turonian siliciclastic-carbonate stage is characterized by alternating offshore mudstone and carbonate facies types deposited in outer/distal middle ramp to proximal middle/ inner ramp setting. Two third-order depositional sequences (DS1 and DS2) are defined within the Cenomanian to Turonian succession. The recognized sequence boundaries (SB1, SB2 and SB3) correspond to the global Cretaceous eustatic curve as well as to counterparts in Egypt, Jordan, Tunisia and American/European basins. The SB1 surface signifies subaerial exposure that was followed by early Late Cenomanian transgression and deposition of siliciclastic-dominated strata of DS1. Subsequent Late Cenomanian base-level fall resulted in generating the sequence boundary SB2. The SB3 surface coincides with Middle Turonian base-level fall, which heralds the boundary between the Early and Middle Turonian. The proposed model shows how carbonate production is controlled basically by the base-level changes and sediment supply, in addition to other paleoecologic carbonate-production factors.

In : Journal of African Earth Sciences ; vol. 147, 2018, p. 352-373.

27 : Depositional history of the Late Barremian deposits (Sidi Aïch Formation) in central Tunisia and adjacent parts of Algeria: a geostatistical revelation. ALOUI T., OUNIS A., DASGUPTA P., LOURIMI W., CHAABANI F.

Keywords : Facies analysis ; Late Barremian ; Entropy analysis ; Markov chain ; Sidi Aïch Formation ; Algeria ; Central North Africa.

Abstract : The lithofacies analysis of the Sidi Aïch Formation and equivalents in Tunisia and adjacent parts of Algeria was carried out using probabilistic and quantitative approach as Discrete Time Markov Chain (DTMC) and entropy functions coupled with detailed sedimentary analyses with a view to decipher the Late Barremian depositional history. The Late Barremian successions exhibit asymmetric, fining-upward and retrograding to aggrading cycles in both outcrop and borehole data. Complete cycles typically start with intraformational conglomerates or trough and planar cross-stratified coarse sands, overlain by finegrained sands, which are succeeded, in turn, by laminated sands, silts, clays and carbonates, and ends with paleosoils. Such ideal succession of lithofacies is observed at Zemlet el Baidha Hill in Tunisia and OuM.1 borehole in northeast Algeria marked by high values of entropy. The entropy analysis indicates deposition in a neritic environment with interplay of fluvial (and rarely alluvial) processes. The facies associations observed at Zemlet el Baidha Hill document evidences of wave and tide dominated coast with complex-gradient of environments that graded from neritic (upper to lower shoreface) to coastal settings (lagoons, embayments, restricted bays, mires, swamps etc.). The architecture of lithofacies appears to have been controlled by autocyclic processes (effects of local tectonics, basin bathymetry, lateral redistribution of deposits by longshore waves and tide currents) and allocyclic processes (global decrease of relative sea-level and sediments supply). Due to large salinity variations, wave action, ephemeral and local aspects of these marginal environments, the ichnodiversity was often limited in time and space, and inhibited the development of fossils during the onset of deposition of Sidi Aïch Formation and its equivalents.

In : Journal of African Earth Sciences ; vol. 143, 2018, p. 278-300.

28 : Neogene palaeochannel deposits in Sudan – remnants of a trans-Saharan river system ? BUSSERT R., EISAWI A.A.M., HAMED B., BABIKIR I.A.A.

Keywords : Palaeochannel ; Conglomerate ; Neogene ; Incised valley ; Nile ; Trans-Saharan.

Abstract : The start of Nile-type trans-Saharan drainage systems in NE Africa during the Cenozoic is disputed. Stratigraphical and sedimentological data in Egypt are partly in conflict with the uplift history of potential source areas of water and sediment in East Africa. Here, we investigate outcrops of the Wadi Awatib Conglomerate in Sudan that provide the first evidence of northerly flowing Neogene rivers in the region. Dimension and relief of basal erosion surfaces, overall geometry of deposits and paleocurrent indicators demonstrate that the deposits represent the fill of northward-oriented incised valleys. The conglomerates were deposited in deep gravel-bed rivers, by hyperconcentrated flows, tractions carpets and gravel bars, primarily during heavily sediment-laden floods of probably monsoonal origin. Stratigraphical and geomorphological relationships show that the deposits are between Eocene and Pliocene in age. Considering the structural history of the region and periods in the Cenozoic with palaeoclimatic conditions suitable for the production and transport of gravels, we hypothesize that the dramatic base-level fall during the Late Miocene Messinian salinity crisis in combination with a favorable palaeoclimate caused the incision of valleys and their subsequent filling with conglomerates. Sea-level change in the Mediterranean Sea and headward erosion of streams that were connected to the Egyptian Nile might have been the primary cause of valley incision and deposition of conglomerates, despite a location far inland from the coastline. We suggest that the deposits document a relatively young Neogene (Messinian to early Pliocene) trans-Saharan river system unrelated to uplift of the Ethiopian Plateau.

In : Journal of African Earth Sciences ; vol. 141, 2018, p. 9-21.

29 : Molluscan and sedimentological sequences of the late Quaternary deposits of Morsott region (NE Algeria) and their paleoenvironmental implication. CHELLAT S., TOUBAL L., DJERRAB A., BOUREFIS A., HAMDIAISSAB, SALMI-LAOUAR S.

Keywords: Fluvio-lacustrine ; Malacology ; Isostasis ; Hygrophilous organisms ; Morsott ; NE Algeria.

Abstract : The late Quaternary sequences of north-eastern Algeria composed of alternating dark and light layers, which are rich in molluscan fauna, could correspond to synchronous environmental phases. The facies variations of the Morsott region deposits were systematically sampled as part of a sedimentological and malacological study in order to establish a palaeoenvironmental and climatic reconstruction of the late Quaternary. The alteration of sandy clayey silts levels, which contain abundant molluscan hygrophilous organisms, indicates an isostasis cycle followed, at the top, by a succession of rhexistasis and biostasis cycles. The molluscan record shows a dominant succession of xerophilous organisms in relation to the hygrophilous organisms. The faunistic richness in the fine levels is linked to sub-humid periods where the region has suffered numerous floods. The reduction in the number of species in the coarse levels comes is likely due to desiccation when the climate was semi-arid. This study is new in Algeria and will provide an insight into climatic changes. Further research will be required in order to understand the fluvial dynamics during the Quaternary.

In : Bull. Soc. Géol. France – Earth Sciences Bulletin; t. 189, n° 4-6, 2018, 17-13p.

30 : Etude sédimentologique et ichnologique de la Formation des Argiles de Saïda (Jurassique supérieur) dans les monts de Frenda (Algérie nord-occidentale). CHERIF A., BENOUCHEF M., FERRE B., BENHAMOU M.

Mots-clés: Oxfordien; Faciès; Plate-forme; Ichno-faciès à *Cruziana*; Argiles de Saïda; Monts de Frenda; Algérie.

Résumé : Le présent travail est une étude sédimentologique et inologique de la Formation des Argiles de Saïda, d'âge oxfordien, dans les Monts de Frenda (Nord-Ouest algérien). L'étude sédimentologique montre qu'elle comporte trois associations de faciès distinctes. La première est formée d'alternance d'argiles et de grès, montrant des rythmites tidales, stratifications lenticulaires, laminations horizontales, laminations de rides de vague, litages obliques en mamelon « HCS », litages obliques et entrecroisés, laminations convolutées et structures d'échappement de fluide. Elle indique un environnement d'estran (« foreshore ») à influence mixte (tidal et vague). La deuxième association est formée par des argiles intercalées de bancs gréseux à laminations de rides de vagues et (« HCS ») ; elle atteste d'un milieu d'avant-plage supérieure (« upper shoreface ») sous l'influence de tempêtes. La troisième association de faciès est principalement composée d'argiles à intercalations de grès riches en ichnofossiles et de calcaires à faune benthique, représentant un milieu d'avant-plage inférieure (« lower shoreface »)-océanique ouvert (« offshore »). L'étude ichnologique nous a permis de reconnaître les ichnotaxons suivants : ?*Archaeonassa*, ?*Cruziana problematica*, *Lockeia*, *Palaeophycus*, *Phycodes*, *Protovirgularia*, *Rhizocorallium*, *Spongeliomorpha*, *Taenidium* et *Thalassinoides*. Ces traces fossiles indiquent l'ichno-faciès à *Cruziana*.

In : Revue de Paléobiologie; vol. 37, n° 1, 2018, p. 121-135.

31 : Shoreface facies model of Cretaceous Jessu Formation, Yola Sub-basin, Northern Benue Trough, northeast Nigeria : new insights from facies analysis and molecular geochemistry. SARKI YANDOKA B.M., ABDULLAH W.H., ABUBAKAR M.B., JOHNSON H., ADEGOKE A.K., ARABI A.S., BATA T.P., AMIR HASSAN M.H., MUSTAPHA KH. A., USMAN M.B.

Keywords : Offshore ; Shoreface ; Facies models ; Jessu formation ; Yola Sub-basin ; Nigeria.

Abstract : The Yola Sub-basin in the Northern Benue Trough is a frontier exploration basin in northeastern Nigeria and to date, there is no subsurface data available. The oldest sedimentary unit in the Yola Sub-basin is the Bima Formation, followed by Yolde, Dukul, Jessu, Sekuliye, Numanha and Lamja Formations, ranging in age from Berremian-Aptian-Albian to Santonian. The sediments of Jessu Formation were studied based on facies analysis (lithofacies and palynofacies) and geochemistry (biomarker distribution) with an objective of analysing and interpreting the source input/origin, paleodepositional conditions, paleodepositional environment and to reconstruct depositional and facies model for the studied successions. The study revealed that the sediments were deposited in a distal oxic-suboxic to relatively anoxic shelf (shallow marine) environment with both aquatic, marine and terrestrially derived source inputs. Depositional framework indicate a progradational wave and storm-dominated shoreface-offshore facies succession, displaying a coarsening upward trend. This represent a regressive shoreface-offshore depositional system, consistent with earlier interpretations that the Cretaceous sediments of Jessu Formation were deposited during a brief regressive phase in the Northern Benue Trough.

In : Journal of African Earth Sciences; vol. 152, 2019, p. 10-22.

32 : Carbonate mounds of the Moroccan Mediterranean margin: facies and environmental controls. TERHZAZ L., HAMOUMI N., SPEZZAFERRI S., LOTFI E.M., HENRIET J.-P.

Keywords : Carbonate mounds; Cold water corals; Sedimentology; Sedimentary geochemistry; Moroccan Mediterranean margin.

Abstract: Sedimentological and geochemical studies of boxcores from the Brittlestar Ridge I and Cabliers carbonate mounds, along the Moroccan Mediterranean margin, show that sediments are composed of cold water scleractinian corals and micritic mud, muddy micrite or muddy allochem limestone matrix, outlining seven different facies that can be attributed to “cluster reefs”. The mixed siliciclastic/carbonate sediments have been derived from both extra- and intrabasinal sources. Extra-basinal sources may be the geological formations outcropping in the Moroccan hinterland and Sahara, the latter including corals and associated bioclasts. Sediments were transported by wind and rivers and redistributed by bottom currents and local upwelling. Our results confirm the role of tectonics in the genesis of these carbonate mounds and reveal that their developments during the Holocene (10.34-0.91 ka Bp) was controlled by climatic fluctuations (e.g. Holocene Climate Optimum and Little Ice Age), eustatic sea level change, and hydrodynamic regime.

In: C. R. Acad. Geoscience; vol. 350, n° 5, 2018, p. 212-221.

GEOLOGIE REGIONALE–CARTES

33 : Apport de l'imagerie radar par la technique SBAS à la mesure des mouvements de masses causés par l'exploitation de carrière dans les Monts des Beni Chougrane, cas de Djebel Aoud Asma (Wilaya de Mascara, Algérie). BACHIR BELMEHDI F., LESGAA M., HASNI K.

Mots-clés : Exploitation de carrières ; Image SAR ; Mesure de déplacement ; Technique SBAS ; Monts de Ouled Ali ; Dj. Aoued Asma ; Wilaya de Mascara ; Algérie.

Résumé: L'analyse et la compréhension de la dynamique des milieux physiques par l'exploitation de carrières constituent un enjeu fondamental en matière de prévention de déclenchement des risques naturels. Les Monts de Ouled Ali (Monts des Beni Chougrane) comportent des zones fortement instables qui rendent vulnérables le milieu naturel de la région de Sig (wilaya de Mascara), l'observation et la mesure des déplacements en surface représentent le moyen le plus simple pour la surveillance des carrières.

Les versants de Dj. Aoud Asma une des régions touchées par l'exploitation de carrières sont le sujet de notre étude ayant pour objectif de caractériser leur cinématique par l'utilisation de l'imagerie radar (SAR).

Cette technique est un outil très intéressant dans le domaine de mesure des déplacements superficiels sur toute la région d'étude, d'une façon dense et précise.

Dans ce contexte, la méthode des petites lignes de bases (en anglais: Small Baseline SBAS) a été employée et qui se base sur le principe d'utilisation des bases temporelle et spatiale minimales des couples interférométriques utilisés, pour assurer une corrélation optimale. Le travail abordé concerne le traitement interférométrique par la technique SBAS de 31 images SAR sur la région de la carrière, pendant une durée de 08 ans à partir de Février 2003.

L'analyse des différents résultats nous a permis de mettre en évidence des déplacements verticaux de la zone d'étude, notamment à partir de 2006 (l'année de l'installation de la cimenterie LAFARGE et début de l'exploitation de la carrière).

In: Bulletin des Sciences Géographiques ; n° 31, 2018, p. 54-64.

34 : Glossaire unifié de la terminologie relative à l'information géographique. CONSEIL NATIONAL DE L'INFORMATION GEOGRAPHIQUE.

Mots-clés : Information géographique ; Glossaire ; Terminologie ; Norme internationale ISO ; Algérie.

Résumé: Cette première édition du glossaire, comprend une variété de termes utilisés dans les différentes thématiques de l'information géographique tels que la géodésie, la cartographie, la télédétection, les systèmes d'informations géographiques (SIG), etc...

La structuration du présent document s'est faite en trois parties où chaque terme ayant son équivalence en français, en arabe et en anglais avec les définitions dans les trois langues sus²²citées.

Les définitions des termes retenus dans ce glossaire ont été puisé dans des références documentaires faisant autorité en la matière et qui sont citées dans les références bibliographiques ayant prévalu à son élaboration. Certaines définitions en arabe et en l'absence de sources trilingues de la définition d'un terme géographique, un effort a été fourni dans la recherche des explications les plus pertinentes possibles pour compléter les définitions manquantes.

In: Conseil National de l'Information Géographique; 1^{ère} Ed., 2019, 167 p.

35: Cartography. FIELD K.

Keywords: Maps; Cartography.

Abstract: A lavishly illustrated reference guide, *Cartography*. by Kenneth Field is an inspiring and creative companion along the nonlinear journey toward designing a great map. This compendium for contemporary mapmaking distills the essence of cartography into useful topics, organized for convenience in finding the specific method or subject you need. Unlike books targeted toward deep scholarly discourse of cartographic theory, this book provides sound, visually compelling information that translates into practical ideas for modern mapmaking. At the intersection of science and art, *Cartography*, serves as a guidepost for designing an accurate and effective map and makes a strong statement about the worth of cartography and cartographic thinking.

In: Esri press, 2018, 549 p.

36: Mapping with ArcGIS Pro. Design accurate and user-friendly maps to share the story of your data. ROCK A., MALHOSKI R.

Keywords: Maps; Cartographic design techniques; Projection; ArcGIS Pro.

Abstract: ArcGIS Pro is a geographic information system for working with maps and geographic information. This book will help you create visually stunning maps that increase the legibility of the stories being mapped and introduce visual and design concepts into a traditionally scientific, data-driven process.

The book begins by outlining the steps of gathering data from authoritative sources and lays out the workflow of creating a great map. Once the plan is in place you will learn how to organize the Contents Pane in ArcGIS Pro and identify the steps involved in streamlining the production process. Then you will learn Cartographic Design techniques using ArcGIS Pro's feature set to organize the page structure and create a custom set of color swatches. You will be then exposed to the techniques required to ensure your data is clear and legible no matter the size or scale of your map. The later chapters will help you understand the various projection systems, trade-offs between them, and the proper applications of them to make sure your maps are accurate and visually appealing. Finally, you will be introduced to the ArcGIS Online ecosystem and how ArcGis Pro can utilize it within the application. You will learn Smart Mapping, a new feature of ArcGIS Online that will help you to make maps that are visually stunning and useful.

By the end of this book, you will feel more confident in making appropriate cartographic decisions.

In: Packt Publishing Ltd, 2018, 251 p.

PALEONTOLOGIE

37: Les foraminifères benthiques du Jurassique moyen du Haut Atlas de Rich-Gourrama (Maroc): biostratigraphie, renouvellements et stratégies d'adaptation. BOURHIM L., AMHOUD H., SADKI D., AIT ADDI A., CHBANI B., AKASBI A.

Mots clés : Foraminifera ; Jurassique moyen ; Biostratigraphie ; Paléoécologie ; Adaptation ; Haut Atlas marocain.

Résumé : La distribution stratigraphique synthétique des principales espèces de foraminifères benthiques telle qu'elle se dégage des faciès de l'Aalénien au Bathonien basal du Haut Atlas centro-oriental (régions de Rich-Gourrama) montre des relais de différentes associations d'espèces de foraminifères benthiques. Cette distribution, qui se traduit par des variations progressives ou des changements importants de la microfaune, nous a permis :

- d'établir un découpage biostratigraphique grâce aux espèces indicatrices. Quatre associations comparables à celles identifiées dans d'autres bassins marocains pour la même période sont ainsi reconnues : (1) associations à *Lenticulina galeata* et *Garantella ampasindavaensis*, (2) association à *Lenticulina quenstedti* et *Garantella stallata*, (3) association marquée par l'explosion des agglutinés et des formes du genre *Lenticulina* à test costulé et déroulé, et (4) association à dominance des formes agglutinées ;

- de suivre l'évolution des peuplements microfauniques en relation avec les changements des conditions paléoenvironnementales (bathymétrie, oxygénation, nature du substrat). Les traces de ces changements sont ainsi fidèlement enregistrées par des foraminifères qui adoptent différentes stratégies, exprimées par des modifications morphologiques concernant, entre autres, la forme du test, le mode d'enroulement et la surface externe du test.

Les fréquences relatives des groupes de foraminifères reconnus dans les différents lavages réalisés en plusieurs points de chaque coupe au cours de cette période montrent, ainsi, une écoséquence en parfait accord avec l'évolution des dépôts.

In : *Revue de Paléobiologie (Genève)*; vol. 38, n°1, 2019, p. 125-149.

38 : Large-sized theropod *Spinosaurus*: an important component of the carnivorous dinosaur fauna in southern continents during the Cretaceous. CANDEIRO C.R.A., GIL L.M., CASTRO P.E.P.

Keywords: Theropod dinosaur ; Distribution ; Early Cretaceous ; Algeria ; Egypt ; Morocco ; Tunisia ; Africa.

Abstract : The Early Cretaceous of North Africa has Spinosaurinae dinosaur remains such as *Spinosaurus* recorded in Algeria (Guir Basin, Kem Kem beds), Egypt (Bahariya Formation), Morocco (Kem Kem beds), and Tunisia (Ain El Guettar Formation). Until now, three possible *Spinosaurus* species were identified: *Spinosaurus aegyptiacus*, *Spinosaurus* sp. and *Spinosaurus* « B ». The occurrence of this genus in the Albian-Cenomanian rocks of Africa suggests that the temporal and geographic distribution of these spinosaurines is the largest one among all genera and species of megapredators from the middle Cretaceous of Africa. The fossil record of *Spinosaurus* from the Albian to the Cenomanian shows a 20 million year persistence of this genus in Gondwanan ecosystems.

In : *Bull. Soc. Géol. France – Earth Sciences Bulletin*; t. 189, n° 4-6, 2018, 15-9 p.

39 : New fossils of the giant pholidosaurid genus *Sarcosuchus* from the Early Cretaceous of Tunisia. DRIDI J.

Keywords : *Sarcosuchus* Osteoderms ; Palaeobiogeographic distribution; Palaeoecology; Lower Cretaceous; Tataouine basin; Tunisia; Algeria.

Abstract : The Lower Cretaceous vertebrate assemblages from southeastern Tunisia contain one of the most diverse, unique and significant vertebrate faunas of this period in North Africa. The fossil record of crocodyliforms from these assemblages is becoming better understood with the increasing number of palaeontological discoveries that have been made over the past few years. However, very little data is available on the North Gondwanan pholidosaurid crocodyliform *Sarcosuchus* due to the paucity of material likely because of selective taphonomic factors. Here, I describe and figure new fossils of the pholidosaurid genus *Sarcosuchus* from Aptian-Albian deposits of the Tataouine Basin in southeastern Tunisia. These fossils include well-preserved dorsal osteoderms, which were found in anatomical connection, several isolated teeth and fragmentary remains mostly pertaining to the appendicular and axial skeletons. Anatomical studies and comparisons with other specimens have been performed, supporting the attribution of the material to the genus *Sarcosuchus*. I show that no attempt at a specific level can be made on the basis of the present fossils. The large size of the osteoderms and the stout conical teeth indicate that many *Sarcosuchus* individuals reached enormous body sizes.

Sarcosuchus would have prospered in a flood dominated river-delta system that characterized the Tethyan margin of Gondwana by the end of the Lower Cretaceous. The abundant remains of diverse fish taxa including actinopterygians, sarcopterygians and chondrichthyans are indicative of a productive ecosystem, and further suggest that the diet of the Tunisian taxon included large bodied fish. This discovery provides a substantial addition to the extremely poor record of the North African crocodylomorphs with new insights into their palaeobiogeographic distribution, palaeoecology and extinction.

In : *Journal of African Earth Sciences* ; vol. 147, 2018, p. 268-280.

40 : Foraminiferal biostratigraphy and bioevents of the Cenomanian-Turonian succession in southern Sinai, Egypt and relationship to OAE2. EL BAZ S.M., KHALIL M.M.

Keywords : Cenomanian ; Turonian ; Foraminifera ; Biostratigraphy ; Bioevents ; Sinai ; Egypt.

Abstract : The shallow water Cenomanian-Turonian succession exposed in the southern Sinai was examined to distinguish the biostratigraphic zonations, based on the foraminiferal associations, and to define the significant bioevents that occurred during this interval. This succession is subdivided into two rocks units, namely the Raha and Abu Qada formations. According to the lithological characteristics, the Raha Formation is subdivided into the Abu Had and Mellaha Sand members. The foraminiferal association consists of 33 species (23 benthic and 10 planktic). Planktic foraminifera are distributed only in sporadic intervals. Relying on the combination of benthic and planktic foraminifera, four local biozones are established including, *Daxia cenomana-Mayncina d'orbignyi*, *Biplanata peneropliformis-Nezzazata convexa*, *Thomasinella punica*, and *Whiteinella archaeocretacea*. In this study, the Cenomanian-Turonian boundary is characterized by a sequence of significant bioevents beginning with the extinction of some benthic foraminifera (e.g., *Thomasinella* spp.), followed by a bloom of the low-oxygen tolerant planktic foraminifera (heterohelicids), a flood of calcispheres and microfilaments, and then the dominance of whiteinellids. These bioevents could be recognized as a key for a global turnover that occurred across the Cenomanian-Turonian boundary associated with Oceanic Anoxic Event 2.

In : *Journal of African Earth Sciences*; vol. 150, 2019, p. 310-318.

41 : *Eressella*, a new uncinuloid brachiopod genus from the Middle Devonian of Europe and Africa. HALAMSKI A.T, BALINSKI A.

Keywords: Systematics ; Brachiopoda ; Rhynchonellida ; Devonian ; Germany ; Poland ; Morocco.

Abstract : *Eressella*, a new genus of rhynchonellide brachiopods belonging to the superfamily Uncinuloidea Rzhonsnitskaya, 1956, is described with *Rhynchonella coronata* Kayser, 1871, as the type and only species. It is characterised by a dorsibiconvex profile with a resupinate ventral valve, costae rounded posteriorly, but acute and developing ventrally directed spur-like protuberances anteriorly, small dental cavities, cardinal process multilobed posteriorly and massive anteriorly, and the presence of a septalium and thick dorsal median septum. Given the present state of flux in the systematics of the superfamily, it is conventionally placed within the family Uncinulidae Rzhonsnitskaya, 1956, although similarities with the subfamily Betterbergiinae Savage, 1996 and the family Eucharitinidae Sartenaer, 2015 are also noted. *Eressella coronata*, hitherto the only representative of the genus, is known from the Eifel Hills (Eifelian, mainly middle Eifelian), from central Poland (especially from the Eifelian of the Holy Cross Mts.), and from the Moroccan Anti-Atlas (late Eifelian to early Givetian, details uncertain).

In : *Annales Societatis Geologorum Poloniae* ; vol. 88, n° 1, 2018, p. 21-35.

42 : The late Aptian requieniid rudist *Pseudotoucasia catalaunica* Astre from the Mediterranean region with emphasis on Moroccan occurrences of the species. MASSE J.-P., HADACH F., FENERCI-MASSE M., ALGOUTI A., ALGOUTI AB.

Keywords : Rudist bivalves ; Requieriidae ; Taxonomy ; Aptian ; Morocco ; Tunisia ; Algeria.

Abstract : *Pseudotoucasia catalaunica* is identified from Upper Aptian beds of the western High Atlas of Marrakech, in Morocco. This species differs from *Pseudotoucasia santanderensis* by the shape of the RV myophore, the shell size and the morphology of the posterior side of the right valve, but the two species are phylogenetically related. We document the presence of *Pseudotoucasia catalaunica* in Algeria and Tunisia, therefore its geographic distribution includes Spain, SW France, the Maghreb and the Black Sea coast of Turkey, regions in which the species is restricted to the Upper Aptian.

In : *Journal of African Earth Sciences*; vol. 151, 2019, p. 548-554.

43 : Les ammonites du Cénomaniens des massifs de Hameimat (Tébessa, Atlas saharien oriental, Algérie) : systématique et biostratigraphie. MENDIR S., SALMI-LAOUAR S., FERRE B., BELHAI DJ., AOUISSI R., DEGAÏCHIA A.

Mots clés : Ammonites ; Cénomaniens ; Systématique ; Biostratigraphie ; Hameimat ; Atlas saharien oriental ; Algérie.

Résumé : Situés au nord de Tébessa (Atlas saharien oriental), les massifs de Hameimat Nord (HN) et de Hameimat Sud (HS) comportent de vastes affleurements cénomaniens riches en macro-invertébrés marins. Parmi les ammonites récoltées, 15 espèces sont décrites et identifiées. L'analyse biostratigraphique de ces ammonites permet d'établir une subdivision du Cénomaniens de Hameimat. Quatre biozones y sont reconnues : zone à *Mantelliceras mantelli* (partie moyenne du Cénomaniens inférieur), zone à *Acanthoceras rhotomagense* (partie moyenne du Cénomaniens moyen), zone à *Calycoceras naviculare* (base du Cénomaniens supérieur) et zone à *Metoicoceras geslinianum* (partie moyenne du Cénomaniens supérieur). La zone à *Mantelliceras mantelli* peut être scindée en deux sous-zones : sous-zone à

Sharpeiceras schlueteri et sous-zone à *Mantelliceras saxbii*. La comparaison des résultats obtenus avec les données des régions avoisinantes (Boukhadra, Morsott et Ouenza) permet de compléter la biozonation locale. Elle révèle également d'étroites similitudes avec les assemblages du Kalaat Senan (Tunisie) et du NW de l'Europe. La répartition géographique assez large de ces ammonites durant le Cénomaniens atteste d'une homogénéité faunistique et d'une appartenance à un même domaine paléobiogéographique ; elle permet alors de préciser les corrélations entre les deux marges du domaine téthysien.

In : *Revue de Paléobiologie (Genève)*; vol. 38, n°1, 2019, p. 229-254.

44 : New sections of the Cretaceous-Paleogene transition in the southwestern Tethys (Médéa, northern Algeria) : planktic foraminiferal biostratigraphy and biochronology. METSANA-OUSSAID F., BELHAI DJ., ARENILLAST J.-A., ARZJA., GILABERT V.

Keywords: Micropaleontology; Graphic correlation; Danian; Maastrichtian; Tell Atlas; Médéa; Algeria.

Abstract : Two sections (Sidi Ziane and Djebel Zakhamoune from Médéa, northern Algeria) of the Cretaceous-Paleogene (K-Pg) transition have been found, sampled, and studied in detail for the first time in Algeria. In order to obtain a biochronological control to evaluate the potential of the Médéa area for the study of the K/Pg boundary event and close paleoclimatic episodes as LMWE and Dan-C2, we have reviewed the biostratigraphical scales with planktic foraminifera from the uppermost Maastrichtian to the middle Danian and dated the main key bioevents through graphic correlations comparing the Bottaccione (Italy), Agost and Caravaca (Spain), and Kalaat Senan (Tunisia) sections. The biostratigraphic study has revealed the presence of the last biozone of the Maastrichtian in both sections (zone CF1 or *Plummerita hantkeninoides* zone). The thickness of this biozone (13.5 m in Sidi Ziane and 9 m in Djebel Zakhamoune) is one of the largest identified to date, suggesting that the uppermost Maastrichtian is complete and continuous in the Médéa area. Based on graphic correlation, it has been determined that sedimentation rates of the Maastrichtian in Sidi Ziane and Djebel Zakhamoune are, respectively, 8.98 and 6.58 cm/kyr, only comparable with the most expanded and continuous sections worldwide, such as Aïn Settara (Kalaat Senan). It has also recognized a hiatus affecting the lower Danian in both sections, estimated in 610.4 and 644.9 kyr long in Djebel Zakhamoune and Sidi Ziane, respectively. Nevertheless, the presence of reworked specimens of the index species *Parvularugoglobigerina longiapertura* strongly suggests that the lowermost Danian may be recorded in the Médéa area.

In : *Arabian Journal of Geosciences* ; vol. 12, n° 6, 2019, 217-34 p.

45 : Presence of the foraminifer *Chapmanina gassinensis* Silvestri, 1931, in the Eocene (Lutetian) of the Grignon « falunière » (Yvelines, Paris Basin). The genus *Chapmanina*, its species and world distribution. POIGNANT A.

Keywords: Foraminifer; Eocene; Oligocene; Palaeobiogeographical distribution; Paris Basin; France.

Abstract: *Chapmanina gassinensis* (foraminifer) has been observed as it seems for the first time in the Lutetian of the "falunière" of Grignon (Yvelines, southwestern Paris Basin). It is widespread in the Eocene of western Europe, also present in the Tethysian domain *l.s.* and even across the Atlantic. In the Oligocene, it becomes very rare and has been only found in some places of Mediterranean Europe and disappears in the Miocene. The Paris Basin seems to be its northernmost occurrence.

In: *Geodiversitas*; vol. 40, n° 12-17, 2018, p. 461-470.

46 : Prédiction du sexe à partir d'un échantillon de métacarpes de chèvres (*Capra hircus* L., 1758) de race Arabia (Algérie) : réalisation d'un référentiel pour l'archéozoologie. RIDOUH R., TEKKOUK-ZEMMOUCH F., THORIN CH., GUINTARD C.

Mots clés : Ostéométrie ; Dimorphisme sexuel ; Métacarpe ; Race Arabia ; *Capra hircus* ; Chèvre ; Algérie.

Résumé : La prédiction du sexe à partir d'ossements issus de sites archéologiques nécessite des outils de comparaison et des collections de références qui soient les plus proches possible du type morphologique étudié. La race autochtone de chèvre algérienne (Arabia) est de ce point de vue une population ancienne et de taille petite à moyenne qui répond parfaitement à l'attente des archéozoologues. L'analyse du dimorphisme sexuel dans l'espèce caprine n'a fait l'objet que de très peu d'études, nous nous proposons donc d'approfondir la question, à partir d'un échantillon de 62 métacarpes gauches de chèvres de race Arabia. Pour chaque animal, le poids de carcasse, l'âge et le sexe ont été notés. Une fois préparé par cuisson, chaque os a été mesuré (7 mesures linéaires) et les indices de gracilité de l'extrémité proximale et de

la diaphyse ont été calculés. Le dimorphisme sexuel est bien marqué et l'ostéométrie des métapodes permet de sexer l'échantillon sans trop de problème. Le fait qu'il y ait des individus jeunes dans l'échantillon rend l'analyse plus compliquée, mais se rapproche plus de ce que les archéozoologues peuvent rencontrer sur le terrain. Une régression logistique permet de faire une prédiction du sexe à partir des mesures linéaires réalisées.

In : Revue de Paléobiologie (Genève); vol. 38, n°1, 2019, p. 255-265.

47 : *Durania cornupastoris* rudist from the Turonian of El-Hassana Dome (Abu Roash area), Egypt : systematic palaeontology and palaeoecology. SALAMA Y., ÖZER S.

Keywords : Turonian ; Rudist ; *Durania cornupastoris* ; Systematic ; Palaeoecology ; Abu Roash ; Egypt.

Abstract : Based on newly-collected exhaustive rudist materials from the Turonian Abu Roash Formation at El-hassana dome, *Durania cornupastoris* (Des Moulins) was clearly-identified. In many literatures, the *Durania arnaudi* (Choffat) is considered a synonym of *Durania cornupastoris* (Des Moulins). Our investigation is based on several characteristics that include dimensions, ornamentation, radial bands, interbands and shell microstructures of the right valves. These characters and comparison with specimens described in the literature were used to identify the collected specimens as *Durania cornupastoris* and differentiate it from *Durania arnaudi*. The external shape of the shell, widths of the radial bands and number of the longitudinal ribs in the interband were the main characteristics of *Durania cornupastoris*. In the described right valves, the interband (Ib) is bulge and has four to six ribs that excluded an attribution to *Durania arnaudi*. Moreover, the ventral radial band (Vb) of *Durania cornupastoris* is wider than the posterior one (Pb). The ecological and taphonomic characteristics of *D. cornupastoris* were highlighted. The elevator *D. cornupastoris* rudists of El-Hassana Dome form significant biostrome in shallow marine environments. The *D. cornupastoris* individuals are in growth position and they are densely packed. The borings are distributed on the *D. cornupastoris* shells. Moreover, these shells exhibit compaction features that appeared as fractures, deformation and/or destruction of the cellular structures in the right valves. The borings and the fractures in the shells are filled with silica materials during the silicification process. The carbon isotopic data ($\delta^{13}\text{C}$) of the *Durania cornupastoris* from Abu Roash area are similar to those from Sinai. However, the oxygen isotopic values ($\delta^{18}\text{O}$) measured from this species are high when compared with those from the Turonian rudist shells of Sinai.

In : Journal of African Earth Sciences ; vol. 152, 2019, p. 128-139.

48 : La formation des argiles de Saïda (Jurassique moyen d'Algérie occidentale) : biostratigraphie (ammonites) et minéralogies. TOUAHRIA A., DOUAS BENGOUDIRA F., FAGEL N., FONTAINE F., SEBANE A.

Mots clés : Minéralogie ; Biostratigraphie ; Ammonites ; Callovien ; Formation des argiles de Saïda ; Algérie.

Résumé : La coupe étudiée est située dans la région de Saïda, dans le nord-ouest de l'Algérie, aux environs de la localité des « Eaux Chaudes » (Hammam Rabbi). Elle montre la succession de plusieurs blancs calcaires et gréseux appartenant au membre inférieur de la Formation des Argiles de Saïda daté du Callovien inférieur à moyen et dont la limite inférieure est marquée par une discontinuité qui correspond à une surface rougeâtre à « galettes » stromatolitiques. Ils s'agit d'un niveau fossilifère repère à la base de la coupe. La limite supérieure de la formation est marquée par des bancs gréseux et plus grossiers. Les faciès sont monotones, essentiellement argileux à marneux, laissant apparaître des niveaux indurés de calcaires.

L'analyse par diffractométrie aux rayons X des échantillons prélevés montre la présence d'un cortège minéralogique composé de calcite, de dolomite, de quartz, de kaolinite, d'illite, de chlorite et d'interstratifiés illite-vermiculite. En revanche, elle révèle l'absence de smectite. Les résultats obtenus à partir d'une étude faunique réalisée sur les ammonites permettent d'élaborer une échelle biostratigraphique locale qui est corrélée à l'échelle méditerranéenne standard.

In : Revue de Paléobiologie (Genève); vol. 38, n°1, 2019, p. 1-17.

49 : Middle Eocene vertebrates from the Sabkha of Gueran, Atlantic coastal basin, Saharan Morocco, and their peri-African correlations. ZOUHRI S., GINGERICH PH., ADNET S., BOURDON E., JOUVE S., KHALLOUFI B., AMANE A., ELBOUDALI N., RAGE J.-C., DE BROIN F.L., KAOUKAYA A., SEBTI S.

Keywords : Vertebrates ; Middle Eocene ; Palaeobiogeography ; Morocco ; Atlantic basin.

Abstract : The Sabkha of Gueran in the Southwest Moroccan Sahara has yielded a rich and diverse fauna of late middle Eocene vertebrates that include the world's richest Bartonian age archaeocete assemblage. Archaeocete remains were described previously and here we report on the rest of the vertebrate fauna. The Gueran fauna includes abundant chondrichthyan species belonging to Lamniformes, Carcharhiniformes and Rhinopristiformes, and actinopterygian assemblage consisting of *Cylindracanthus*, of a siluriform, and of Perciformes. Turtles are represented by at least two marine taxa referred to as Cheloniidae and Dermochelyidae. Crocodylian remains belong to at least two longirostrine species, including gavialoid remains. Snakes are represented by a pseudo-toothed bird (Pelagornithidae). The avian fossil belonged to a gigantic soaring bird and constitutes the earliest occurrence of the genus *Pelagornis*. The presence of proboscideans is attested by dental fragments. This fossil assemblage from Gueran shows affinities with those of the Eocene beds of Egypt and Libya. The numerous shared taxa support a close biogeographical connection between faunas from southeastern and southwestern coasts of the Mediterranean sea.

In : C. R. Acad. Geoscience ; vol. 350, n° 6, 2018, p. 310-318.

PETROLOGIE

50 : Metacarbonatite rocks from Amesmessa area (In Ouzal Terrane), Hoggar shield, Algeria. CHERBAL M., YONEZU K., AISSA D.E., TINDELL T., WATANABE K.

Keywords : Metacarbonatite ; Geochemistry ; Trace elements ; Pyroxenite ; Marble ; Hoggar shield ; Algeria.

Abstract: The Hoggar Shield (South Algeria) belongs to the 3,000 km-long Pan-African Trans-Saharan Belt which formed in the Neoproterozoic and Cambrian, between 750 and 545 Ma. At the western part of this shield, carbonate rocks crop out to the north and south of Amesmessa gold deposit. They occur as lensoid bodies and dikes cross-cutting Archean granulitic rocks, and are consistently associated with mafic rocks and syenite. The petrogenesis of the Amesmessa metacarbonate rocks, which have previously been interpreted as marbles of Archean age, are reconsidered in the present study. Within the Amesmessa area, a small volume of carbonate rocks consisting of calcite, biotite, clinopyroxene, hornblende, olivine and apatite, and are spatially associated with ultramafic rocks, are surrounded by granosyenite, pyroxenite and rhyolite. The cross-cutting relationship and other outcrop features of the area indicate that the carbonate rocks are an intrusive phase and younger than the other surrounding Archean rocks. The average total REE concentration in the metacarbonate is up to 5,700 ppm. However, the associated rocks; syenite and pyroxenite contain only 60 and 12 ppm, respectively. Sr concentration is also high (> 1,390 ppm) which is normally high in carbonatitic rocks and low in limestones. On the basis of available chemical analyses and outcrop evidence, it becomes clear that the Amesmessa carbonate rocks consist of metamorphosed carbonatite.

In: Journal of African Earth Sciences; vol. 153, 2019, p. 268-277.

51 : Petrology ; geochemistry and stable isotope studies of the Miocene igneous rocks and related sulphide mineralisation of Oued Amizour (NE Algeria). LAOUAR R., LEKOUÏ A., BOUÏMA T., SALMI-LAOUAR S., BOUHLEL S., ABDALLAH N., BOYCE A.J., FALLICK A.E.

Keywords : Igneous rocks ; Calc-alkaline ; Zn-deposit ; Hydrothermal alteration ; Stable isotopes ; Oued Amizour ; Algeria.

Abstract : The Oued Amizour granitoids of North Africa, were studied in order to assess the role of magma processes in the formation of the large Zn-deposit in the region. Access to material from a ~800 drillhole cutting the entire igneous succession greatly facilitated the investigation. The rocks reveal, from the top to the bottom, two distinct lithologies ; volcanic, mainly pyroclastic rocks and sub-volcanic microgranitic – plutonic granodioritic rocks. Both lithologies were subject to hydrothermal alteration. The boundary between the two lithologies is marked by a massive, ~10 m thick anhydrite layer. The geochemistry of these rocks shows that they are intermediate to felsic in composition and exhibit high-k to shoshonitic calc-alkaline features with I-type signature. The negative Eu, Sr and Nb anomalies and the high LILE and LREE enrichment observed in the whole igneous suite indicate that the various volcanic and plutonic rocks are genetically related. The granitoids are considered to have formed under post-collisional geotectonic regime during the Miocene, similar to those described in the Alpine Belt of northern Africa.

The main sulphide mineralisation is dominated by sphalerite with rare marcasite, melnikovite, galena and minor but ubiquitous pyrite. The sphalerite ore body of about 20-30 m thick is hosted by hydrothermally altered andesite breccias and volcanic tuff, between the anhydrite layer at the base and the volcanic pile at the top. Replacement, colloform and

open space filling are the main ore texture patterns which indicate hydrothermal processes throughout successive percolation phases.

$\delta^{34}\text{S}$ of sulphides (sphalerite, pyrite and chalcopyrite) vary between -7.2 ‰ and +4.5 ‰ (n = 22 ; mean = -1.3 ‰), suggesting that magmatic fluids have played a major role in the formation of the Oued Amizour Zn-deposit. However, $\delta^{34}\text{S}$ of sulphates (anhydrite and gypsum) which are isotopically heavier ranging between +13.2 ‰ and +20.6 ‰ (n = 10; mean = +16.3 ‰), likely reflect mixing between Miocene seawater sulphate and magmatic sulphur. Fluid inclusion microthermometric measurements on anhydrite and gangue calcite yield a mean temperature of ~200 °C and salinity between 22.3 and 26.6% eq. NaCl. Calcite $\delta^{18}\text{O}_{\text{v-smow}}$ varies between +11.2 and +20.2 ‰ (n = 12, mean = +16.7 ‰) and $\delta^{13}\text{C}_{\text{v-PDB}}$ varies between -3.7 and -11.0 (mean = -7.8 ‰). These results confirm the magmatic origin of the mineralising fluids, with a marked contribution of seawater, for precipitation of the Oued Amizour Zn mineralisation. Low $\delta^{13}\text{C}_{\text{v-PDB}}$ could, however, be attributed to the contribution of carbon from unconsolidated mudstones and/or magmatic carbon. The observed data on the Oued Amizour Zn deposit show that the mineralisation is part of VHMS group with a Kuroko-type signature.

In : Ore Geology Reviews ; vol. 101, p. 312-329, 2018.

52 : The Sidi El Hemissi Triassic « ophites » (Souk Ahras, NE Algeria) : petrology, geochemistry, and petrogenesis. ZANOUDA H.S., LAOUAR R. , SALMI-LAOUAR S., SEBAI A., VERATI CH., BOUHLEL S., BOYCE A.J.

Keywords: Ophites; Geochemistry; Tholeiites; Continental flood basalts; Souk Ahras; Algeria.

Abstract : The Sidi El Hemissi region, Souk-Ahras, is part of the Tellian Atlas where the Triassic sediments tectonically outcrop under the Tellian nappes of the Maghrebide chain. Mafic rocks, mainly gabbros and dolerites, called « ophites » are interbedded as a ~200 x 30 m lenticular body within the Triassic gypsum-rich formation. These rocks show granular, microgranular, and microlithic textures and are composed of plagioclase, amphibole, pyroxene, and scarce olivine crystals. Albitization is the main alteration process, though chloritization, calcitization, and epidotization of ferromagnesian minerals can also be occasionally observed. The major, trace, and rare earth element studies show that these mafic rocks display relatively low P_2O_5 (less than 0.2 wt%) and moderate to low TiO_2 contents (less than 2 wt%) and exhibit low-Ti continental tholeiitic basalt affinity. They are enriched in large ion lithophile elements (LILE) and light rare earth elements (LREE) compared with high field strength elements (HFSE) and heavy rare earth elements (HREE). This, along with the observed weak Nb and Ce anomalies and the low-Ti contents, suggests an enriched mantle source for the generation of the magma, which likely underwent crustal contamination before emplacement within the Triassic sediments.

The petrological and geochemical features of the Sidi El Hemissi ophites show many similarities with the basaltic rocks emplaced during the Late Triassic-Early Jurassic times, now cropping out in north-western Africa, south-western Europe, north-eastern, and south-eastern America. This large magmatic activity is believed to be related to the continental rifting associated with the early stages of the Pangea breakup.

In : Arabian Journal of Geosciences ; vol. 12, n° 8, 2019, 274-16 p.

MINERALOGIE

53 : Minéraux (Ces) qui ont bouleversé l'histoire de l'humanité. CHALINE E.

Mots-clés : Minéraux ; Utilisation ; Civilisation ; Evolution de l'humanité ; Histoire.

Résumé : Cet ouvrage très illustré présente les 50 minéraux qui ont joué un rôle central dans l'évolution de l'humanité, au travers de nombreuses histoires fascinantes sur chacun d'entre eux. Du silex à l'obsidienne, en passant par le bronze et le fer, vous découvrirez l'impact profond que ces minéraux ont eu sur l'histoire économique, culturelle, politique et industrielle, et le rôle qu'ils jouent encore dans notre société moderne.

S'intéressant également à l'époque contemporaine, il retrace l'industrialisation des sociétés marquées par le recours aux combustibles fossiles, par la production d'acier et d'aluminium, sans oublier la maîtrise de l'énergie nucléaire à partir de l'uranium et du plutonium.

In : Editions Artémis pour l'édition française ; 2012, 222 p.

GEOLOGIE MINIERE

54 : Contribution of remote sensing to mapping In-Abeggui gold deposit (Central Hoggar, South Algeria). BOUTRIKA R., DUCROT D., AISSA DJ.-E.

Keywords: Gold-bearing quartz veins; Aplite dike; Gabbros-diorites; LANDSAT 7ETM+; In-Abeggui; Hoggar; Algeria.

Abstract : The area concerned with the application of remote sensing is the In-Abeggui gold deposit in the Eastern part of Laouni terrane (Central Hoggar, South Algeria). This deposit includes a system of gold-bearing quartz veins marked by intense hydrothermal alteration. The gold veins are hosted in a big gabbro-diorite massif, cut by microgranite and aplite dike veins, all situated in a Neoproterozoic volcanogenic basin. The aim of this paper is to use LANDSAT 7ETM+ satellite images for mapping and characterizing gold-bearing veins, faults, and host rocks in the studied area and especially comparing the results with our traditional field work. All of the techniques used, such as colored compositions (CC), spectral band ratio, principal component analysis (PCA), and directional filtering, allowed a better lithological discrimination of the different formations. Moreover, they highlighted a hierarchical distribution of faults and emphasized their preferential directions. As regards lithology, the visualization with colored composition (RGB) of the three principal components (PC1, PC2, PC3) enabled us to clearly distinguish gabbros, diorites, volcanogenic rocks, and detrital rocks. Besides, we could distinguish between various faults, white aplitic dikes, and various gold-bearing quartz veins.

In : Arabian Journal of Geosciences ; vol. 12, n° 2, 2019, 23-10 p.

55 : Afrique (L') un continent aux ressources minières exceptionnelles. EBA A.R.

Keywords : Géologie ; Ressource minière ; Exploitation ; Potentiel minier ; Développement économique ; Afrique.

Abstract : Plusieurs intellectuels du monde peinent à comprendre les raisons du sous-développement exacerbé de l'Afrique alors que ses ressources naturelles minières sont exploitées depuis des décennies et que les chiffres de croissance économique annoncés ces dernières années sont en hausse. Cependant, les organisations internationales croient toujours aux capacités de l'Afrique et estiment qu'elle peut amorcer véritablement son développement économique et social en ayant recours à l'exploitation de ses matières premières minérales encore peu explorées. Pour ce faire, la Banque Mondiale a lancé un projet dénommé « la carte à 1 milliard de dollar » qui produira une carte actualisée des ressources minières de l'Afrique. Dans le but de confirmer l'importance géopolitique et économique de l'Afrique et le caractère géostratégique de ses minerais, ce livre met en évidence l'énorme potentiel minier de l'Afrique tout en faisant le lien avec les questions de développement typiques de ce continent.

In : Ed. L'Harmattan ; 2018, 397 p.

GEOCHIMIE

56 : SHRIMP U-Pb zircon geochronology of the granitoids of the Imiter Inlier : constraints on the Pan-African events in the Saghro massif, Anti-Atlas (Morocco). BAIDADA B., IKENNE M., BARBEY P. , SOULAIMANI A., COUSENS B., HAISSSEN F., ILMEN S., ALANSARI A.

Keywords : Granitoids ; Zircon U-Pb geochronology ; Ediacaran ; Imiter ; Anti-Atlas ; Morocco ; Pan-African.

Abstract : This study presents new U-Pb zircon ages for three granitoid bodies in the Imiter inlier at the eastern part of the Moroccan Anti-Atlas chain, which is located in the northwestern edge of the West African Craton (WAC). Analyses of zircon grains yield the following ages : 538 ± 6 and Ma for the Igoudrane massif, 567 ± 6 Ma for the nearby Bou Teglimt granodiorite, and 582 ± 6 Ma for the Bou Fliou granite. These new data reveal that the Igoudrane massif is younger than previously thought (677 Ma), and that all the granitoids in the Imiter area are Ediacaran in age and are related to the Ouarzazate Group. Sm-Nd isotopic data yield negative $\epsilon_{Nd}(t)$ values (-4.5 to -0.2) and T_{DM} model ages of 1.04-1.82 Ga. These data indicate the presence of an inherited Paleoproterozoic to Archaean component in some zircon grains and show that generation of the parent magmas involved a Neoproterozoic juvenile contribution and recycling of an older crustal component.

These new data allow reinterpreting the geochemical and isotopic data of the granitoids, and revisiting the structural significance to the Igoudrane massif, which was assumed until now to be coeval with the major Pan-African event of the Central Anti-Atlas. They also bring significant constraints to discuss the context and age of deposition of the Saghro Group, which is still a matter of debate. All these data provide evidence of an emplacement of the Imiter granitoids in a subduction complex, which affected all of the Anti-Atlas chain during the Late Proterozoic time.

In : Journal of African Earth Sciences ; vol. 150, 2019, p. 799-810.

57 : Investigating the occurrences of valuable trace elements in African coals as potential byproducts of coal and coal combustion products. CHELGANI S.CH.

Keywords : Coal ; Yttrium ; Lithium ; Gallium ; Vanadium ; Africa.

Abstract : There is a growing attention in valuable trace elements (TEs) in coal and coal combustion products as they can potentially be future resources of valuable TEs. Therefore, understanding the mode of occurrences of valuable TEs in coal has several advantages for their economical and industrial extractions. Since there is limited information on the affinity of valuable TEs in the structure of African coals, this study explores correlations between conventional coal properties and concentration of vanadium, yttrium, gallium and lithium as valuable TEs for a wide range of African coal samples (139 samples) from South Africa, Botswana, Egypt, Tanzania, Nigeria and Zambia by statistical methods. Statistical assessments indicated that the concentrations of Y, V, Li and Ga for these countries are higher than their value in the world coal (on average). The outcomes of assessments showed that the Li, Ga and V are associated with the mineral matter fraction (inorganic affinity) of the coal where they have significant positive correlations with ash and Al (as a major element) and potentially clay minerals are their main bearing minerals. However, statistical explorations suggested that Y may have both the organic and inorganic occurrences in the African coal samples.

In : Journal of African Earth Sciences; vol. 150, 2019, p. 131-135.

58 : Glauconite-bearing sedimentary phosphorites from the Tébessa region (eastern Algeria) : evidence of REE enrichment and geochemical constraints on their origin. KECHICHED R., LAOUAR R., BRUGUIER O., SALMI-LAOUAR S., KOCSIS L., BOSCH D., FOUFOU A., AMEUR-ZAIMECHE O., LARIT H.

Keywords : Phosphorites ; Glauconite ; REE ; Ce-anomaly ; Djebel Onk ; Tébessa ; Algeria.

Abstract : Rare earth element (REE) analyses are reported on glauconite-bearing phosphorites from northeastern Algeria. These rocks of Paleocene-Eocene age are located in the Eastern part of the Saharan Atlas, where two localities were investigated : the Djebel El Kouif in the north and the Kef Essenoun in the south. The latter belongs to the world-class Djebel Onk mining deposit. Petrographic examination indicates that phosphorite from the main layer of the Kef Essenoun deposit has a significant abundance in glauconite grains, while their occurrence in the Djebel El Kouif is restricted to the basal levels. In both deposits, glauconite grains are richer in REEs than other co-existing particles (pellets, coprolites, enameloid and dentine of marine fish teeth), but the glauconites of the Kef Essenoun deposit exhibit significantly higher REE concentration (min = 654 ppm, max = 1760 ppm, average = 1146 ppm) than those of Djebel El Kouif deposit (min = 543 ppm, max = 623 ppm, average = 584 ppm). The whole-rock REE concentrations also show substantial differences between the two deposits and the REE enrichment in the Kef Essenoun main sub-layer is more likely the result of the high glauconite content. PAAS normalized-REE patterns of the glauconite grains display similar patterns between the northern and southern localities with weak negative Ce anomalies and slight middle REE enrichments. On the other hand, the pellets and whole phosphorite grains from the northern deposit indicate a REE source from oxic-suboxic seawater, whereas those from the Kef Essenoun deposit exhibit slight middle REE enriched patterns with weak negative Ce anomaly suggesting a different environment of deposition (i. e. a tendency to reduced conditions). These geochemical results along with previous petrographic studies confirm the allochthonous character of the main phosphorite sub-layer in Kef Essenoun, where winnowing, transport and re-deposition of previously deposited phosphorites resulted in high accumulation and formation of glauconite grains. The glauconitization process of fecal pellets happened in two stages and was controlled by semi-confined micro-environments. This can explain the abundance of glauconite grains in the phosphorites from Kef Essenoun deposit and their restricted occurrence in the basal levels of the Djebel El Kouif outcrop.

In : Journal of African Earth Sciences ; vol. 145, 2018, p. 190-200.

59 : Geochemical characterization and evolution of the groundwater along the flow path, Gharandal watershed, South Sinai, Egypt. MOSAAD S., EL ABD E.S.

Keywords : Geochemical evolution ; Rock-water interaction ; Geochemical modeling ; Stable isotope ; Gharandal watershed ; South Sinai ; Egypt.

Abstract : Gharandal watershed (882 km²) is part of South Sinai, which represent a remote arid area. Groundwater of the Quaternary aquifer, represents the only water resources for drinking, irrigation and domestic use in this watershed. An integrated approach was used to identifying the geochemical processes controlling the groundwater quality and characterize their evolution along the flow path, depending on the hydrogeochemical and isotopic data. The stable isotopes ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) data elucidate that the studied aquifer is ensured by recent recharge from the local rains. The hydrogeochemical results outline that evaporation, rock-water interaction (particularly dissolution of carbonates and evaporates minerals in aquifer matrix) and the cation exchange, are the main geochemical processes accountable for increasing salinity and the evolution of the groundwater along the flow path. The hydrogeochemical facies evolves from Mg-Na-SO₄-HCO₃ at recharge area into Ca-Na-SO₄-Cl at the middle parts of the main channel and finally Na-Ca-Cl-SO₄ in the downstream of the studies watershed. Geochemical modeling (NETPATH) indicating upgrading in the Quaternary aquifer water from the upstream to produce groundwater at downstream portion. The current study recommended that the Quaternary aquifer should be managed in a sustainable way by not pumping more than the recharged on an average annual basis.

In : Journal of African Earth Sciences; vol. 150, 2019, p. 299-309.

HYDROLOGIE

60 : Hydrogeochemistry and strontium isotopes from the Continental Intercalaire and Complex Terminal aquifers in southern Tunisia. ATOUI KH., KAMEL S.

Keywords : Hydrogeochemistry ; Strontium isotopes ; Water-rock interaction ; Basic exchange ; Marine facies ; Southern Tunisia.

Abstract: The spatial distribution of trace elements of strontium (Sr), barium (Ba), bromide (Br), boron (B) and lithium (Li) was investigated in the deeper confined continental Intercalaire (CI) and the underlying confined/unconfined Complex Terminal (CT) aquifers in southern Tunisia. Geochemical analyses and correlation between trace and major elements suggested that dissolution/precipitation of minerals water rock interaction are the main factors responsible for the occurrence of these elements in the two aquifers. However, in the CI Djerid aquifer, in addition to these factors, the process of basic exchange is generally responsible for the large variation in cation concentration (Ca, Na, and K) and the five trace elements of interest. The Sr²⁺ has been used along with Li and other hydrogeological information to trace the extent of leakage from the CI to the CT aquifer. Besides, high ⁸⁷Sr/⁸⁶Sr and Br/Cl recorded in the Tazrarit CI borehole imply that salinity may be derived from a contact with marine facies in the sediment formation.

In : Journal of African Earth Sciences ; vol. 143, 2018, p. 118-133.

61 : Geochemical, isotopic and statistical monitoring of groundwater quality : assessment of the potential environmental impacts of the highly polluted CI water in Southwestern Tunisia. BESSER H., REDHAOUNIA B., BEDOUI S., AYADI Y., KHELIFI F., HAMED Y.

Keywords : CI ; Oil contamination ; Groundwater contamination ; Statistical analysis ; Southwestern Tunisia.

Abstract : Groundwater chemistry depends on a number of natural and anthropogenic processes. Its evolution under natural conditions or in response to human perturbations remains of major concern. Thus, the main purpose of this study is to evaluate the groundwater quality deterioration in Southwestern Tunisia where the increasing water demand is mainly supplied by the deep confined aquifers of SASS (Système Aquifère du Sahara Septentrional) multi-layered system. The permanent exploitation of the deepest Continental Intercalaire (CI) aquifer led to increasing water quality deterioration. Recently, the hydrogeological regime of the aquifer system undergoes a tremendous change resulting in hydrocarbon (HC) contamination on the largest aquifer in Southern Tunisia. A mixing of petroleum substances and CI thermal water is currently pumped from a number of CI water boreholes in Kebili region owing to a spectacular on shore hydrocarbon seepage at SW Tunisia. This contamination is attributed to natural migration by continuous upward petroleum flows via permeable faults, plans of weakness and/or leakage through drilling wells (spilled oil).

The most noteworthy finding of the current study is that the measured chemical composition of CI aquifer water reveals a significant wider distribution than expected. The impacts of the HC pollution are expressed by scattered geochemical, isotopic and statistical data. The hydrogeochemical results indicate that in the Western field, the CI is characterized by low mineralized water (TDS from 0.6 to 2.7 g/l) while towards the East, the CI water becomes mostly polluted with salinity ranging between 3 and 20 g/l and cadmium (Cd) concentrations between 12 and 90 μ /l these values are widely above the permissible limits for both human consumption and agriculture activities. Similarly, the environmental isotopic fingerprinting indicates that CI thermal waters in the contaminated field are influenced by mixing with deep groundwater. The mixing process seems to be facilitated by regional tectonic features such as deep fractures and major faults in the contaminated area. Correspondingly, the statistical analysis (principal Component Analysis (ACP) and Hierarchical Cluster Analysis (HCA) confirm, in turn, the scattered results suggesting the dissimilarity of groundwater composition between the contaminated boreholes and the sampled waters from the western side.

In : Journal of African Earth Sciences; vol. 153, 2019, p. 144-155.

62 : Hydrogeological characterization and aquifer recharge mapping for groundwater resources management using multicriteria analysis and numerical modeling : a case study from Tunisia. CHENINI I., MSADDEK M.H., DLALA M.

Keywords : Aquifer recharge ; Groundwater ; Numerical simulation model ; Water resource ; Tunisia.

Abstract : In hydrogeological modeling, the groundwater flow and the reservoir structure are key factors. The evaluation of the aquifer system functioning and the water availability are the main issues in water resource management. In this study, a groundwater flow model and geographic Information System tools were used to manage water resources in arid area. In this study, multicriteria approach using a weighted-rating process was adopted to establish a map showing areas suitable for groundwater recharge. The high rechargeability index covers 45% of the total shallow aquifer extension and the medium index covers only 29%. Recharge rates are introduced to the established model using the software MODFLOW. The impact of the groundwater recharge is then evaluated by hydraulic heads simulation and water budget analysis. The model exploitation illustrates the impact of the water recharge on the hydraulic heads. In the second scenario, with a constant exploitation and precipitation, the impact of a recharge dam increases the piezometric levels. Results are helpful to manage water resources and to help decision makers and planner.

In : Journal of African Earth Sciences; vol. 154, 2019, p. 59-69.

63 : Le comportement d'un système hydrologique en climat semi-aride ; apport des approches corrélatoires. Etude de cas dans le Hodna (Algérie). TARMOUL S., NEMOUCHI A., SLIMANI S. , LAIGNEL B.

Mots-clés : Débit ; Pluie ; Analyse corrélatoire ; Bassin versant ; Comportement ; Hodna ; Algérie.

Résumé: Cet article se propose d'étudier le comportement hydrologique d'un bassin versant semi-aride en utilisant des approches corrélatoires (corrélogrammes simples et croisés). Ces approches ont été appliquées sur des séries chronologiques des pluies (entrée) et des débits (sortie) au pas de temps journalier sur trois bassins versants des oueds L'ham, Lougmane et Soubella qui font partie des multiples cours d'eau drainant le grand bassin versant du Hodna. L'objectif de cette étude est de montrer l'apport des approches corrélatoires dans la compréhension d'un système hydrologique des bassins semi-arides en Algérie. Ces analyses nous ont permis de faire des déductions sur le fonctionnement de ces systèmes hydrologiques, sur la présence ou l'absence de stockage des eaux dans ces systèmes. Aussi on a déduit que le temps de réponse des bassins à une sollicitation pluviométrique est très rapide, mais il diffère d'un bassin à un autre en raison des caractéristiques morphologiques, géologiques et de l'occupation du sol de chaque bassin. Le bassin de Soubella qui se caractérise par un dense couvert végétal et la prédominance des formations peu perméables a une réactivité moins rapide que les bassins de L'ham et Lougmane qui se caractérisent par des facteurs très favorables au ruissèlement. L'utilisation de ces approches statistiques est un excellent moyen (outil) pour la compréhension de ces systèmes hydrologiques.

In: Bulletin des Sciences Géographiques; n° 31, 2018, p. 35-45.

64 : Assessing data from permanent GNSS stations in Algeria. ABDELLAOUI H., ZAOURAR N., MESLEM A.

Keywords : Satellite system ; Multipath ; Interferences ; GNSS data ; Permanent station ; Algeria.

Abstract : A nationwide project is undertaken since a few years with the purpose to upgrade the geodetic infrastructure by setting up a wide real-time GNSS Continuously Operating Reference Stations (CORS) network. In this perspective a study has been undertaken in the setting of this assignment with the purpose to select eligible sites of the GNSS/CORS network infrastructure. The technical selection criteria were based essentially on the assessment of GNSS data received by already operating GNSS sites.

Two stations have been selected to perform this investigation based on signal interference and multipath evaluation and monument stability analysis through the post-processing of GNSS data supplied by these GNSS sites, there are located in Algiers in the north and Ouargla in the south, namely DZAL and OGLA respectively.

In : Bulletin des Sciences Géographiques ; n° 31, 2018, p. 2-12.

65 : 3D modeling of geoelectrical data : assessment of groundwater potentialities in Hassi R'mel (Southern Algeria). BOUHMADOUCHE F., BOUNIF M.A., AOUDIA M.

Keywords: Electrical resistivity; Modeling; Finite difference method; Inversion; Sounding; Water; Hassi R'mel; Algeria.

Abstract : This work reveals the modeling contribution to the techniques of investigations in the electrical resistivity area. Two campaigns of electric soundings (maximum length AB = 6000 m) were conducted in the Saharan region – Hassi R'mel (Algeria), to supply two new cities with drinking water. An analytical procedure, also known as inversion, was applied to the processing of the registered measurements. The results of this interpretations allowed to locate the porous and permeable formations likely to be aquifers. A simulation algorithm based on the finite difference method has been adapted for the direct calculation of the electrical resistivity data. The obtained models laid a more detailed description of the subsurface structure. So, based on these results adjusted with the help of drill logs of the region, it is believed that the best orientation for the exploitation of these waters in the first evaluated zone (Bellil) is in the Northeast part of the area under investigation, whereas in the second region (Bouzbier), the privileged areas are those located in the North-east and the South-east parts.

In : Arabian Journal of Geosciences ; vol. 12, n° 1, 2019, 11-15 p.

66 : Electromagnetic survey to constraints ore mining exploration in the eastern Anti-Atlas belt (case of Imiter inlier, Morocco) : Application of frequency electromagnetic helicopter-borne method. EL HMIDI F., CHAKIRI S., HAFID M., MANAR A., BEJAJI Z.

Keywords : Electromagnetic data ; Electric parameter ; Geology ; Imiter inlier ; Morocco.

Abstract : The present work is based on data of a geophysical survey of the Imiter inlier that was carried out by DIGHEM^v multi-coil, multi-frequency helicopter-borne electromagnetic system. Its main goals are (i) to interpret the results of this survey in light of regional geological settings ; (ii) to define how geological factors controlled mineralization in the world-class Imiter silver mine, which is located in the central western part of the survey area ; (iii) to correlate the modalities of this control with the electromagnetic response observed in the Imiter mine district ; and (iv) to extend the model thus obtained to the whole study area in view of locating other potentially mineralized ore bodies. The obtained results showed that the Imiter mine district is covered by two important electromagnetic anomalies and three conductor axes, which are interpreted as directly reflecting the presence of metallic deposits in the subsurface. The most intense of these anomalies (B2) is located in the northern bloc of the main Imiter Fault, in an area which is highly fractured by secondary faults, is covered by Ediacaran volcanic and has never been mined. All mineralized bodies exploited so far are localized in the southern block of this important fault and are all essentially hosted by the Cryogenian black shales. Since we have established that there is a direct relation between faulting and mineralization, and that the intensity of the electromagnetic anomaly is directly related to ore concentration in hosted rocks ; we conclude that the area covered by the electromagnetic anomaly B2 would be even more interesting to explore than the southern bloc presently in exploitation. Extending these results to the rest of the survey area, it was found that two other areas to the south-east of the Imiter mine district are also two potentially mineralized zones meriting future exploration.

In : Journal of African Earth Sciences ; vol. 150, 2019, p. 595-606.

67 : Gravity contribution to the geological study of grabens in the northwest region of Tunisia including the Kef Basin region. FRIFITA N., MICKUS K. , ZARGOUNI F.

Keywords : Gravity analysis ; Grabens ; Three-dimensional inversion ; Northern Atlas ; Tunisia.

Abstract : The northern Atlas region of Tunisia is characterized by northeast-trending compressional structures that affected the extensionally formed Late Permian to Mid Cretaceous Tunisian Trough. More recently, Late Cenozoic extensional forces have formed a series of northwest-trending grabens whose origins are partially controlled by geologic structures formed since the Late Permian. In order to aid in determining how these grabens were formed a detailed gravity analysis was conducted in the western region of the Tunisian Trough. The gravity analysis included the construction of a residual gravity field using wavelength filtering which was further analyzed using derivatives, Euler deconvolution and three-dimensional modeling. The resulting residual gravity anomaly field consists of a series of short wavelength maxima that are mainly related to anticlinal structures and minima related to sediment-filled grabens. To better define the structure of the basins, three-dimensional (3D) gravity models were constructed, where the grabens were found to be approximately 3-5 km in thickness and mainly bounded by normal faults and underlain by low density Triassic evaporites. This evaporitic layer was not underlying the entire study area but only in the vicinity of the grabens. In particular, the Kef Basin region was found to be two separate grabens, the Kef and the Ksour located Southeast of the Kef graben. The Kef graben has a maximum thickness of 3-4 km while the wider Ksour graben is between 4 and 5 km thick. The gravity analysis cannot determine exact origin of the grabens but extension is the most plausible cause of the grabens with strike-slip motion may have played a role in the formation of the Ksour graben if not the other grabens. The location of the grabens was controlled by the lateral extent of the Triassic evaporites which provided the rheological weakness to initiate the grabens.

In : Journal of African Earth Sciences ; vol. 150, 2019, p. 811-822.

68 : Contribution of integrated geophysical data in the structural characterization of the El Hamma graben zone (Southern Tunisia): example of a pull-apart basin along the South Atlasic fault Corridor. HASSINE M., BOUZID W., ABBES CH., AZAIEZ H., GABTNI H.

Keywords : Geophysical data; Pull-apart basin; El Hamma graben; South atlasic fault corridor; Southern Tunisia ; Algeria.

Abstract : The El Hamma-Gabes Region in southeastern Tunisia belongs to the crustal shear zone of the South Atlasic Fault Corridor, which corresponds to the Meso-Cenozoic North African margin. So far, most geological works on this region are on the stratigraphic order. However, there are few tectonic and structural studies carried on the style and mechanism of structural deformation. The present work analyzes the subsurface structure of the El Hamma grabens area based on gravity and seismic data, calibrated by stratigraphic and tectonic elements. The El Hamma-Gabes Zone is characterized by a horst and graben system associated with N130°-150° trending parallel extensive/transpressive faults. Two main grabens are recognized : the El Hamma graben in the west and the Chenchou graben in the east. They are separated by the Jebel Hallouga horst. These structures relate to two N100°-120° trending principal shear corridors (PSC) arranged in right echelon, being the Oum Ali-Fejej Shear corridor towards the northwest and the Matmata-Medenine Shear corridor towards the southeast. Stratigraphic and structural data collected from several outcrops were correlated with the tectonic events and paleostress reconstruction. New data shows that the PSCs marked a dextral transpressive kinematic framework during the N80° directed Upper Cretaceous extension. The extensional movements are the N150°-180° Paleogene extension and associated transpression during the N130° Neogene shortening. The dextral sliding generated and maintained the opening of the El Hamma-Gabes graben system, creating a « pull-apart » basin that opened in an extensive ramp between the two PSCs. The overall extension of this ramp is estimated to 15% of the initial width.

In : Journal of African Earth Sciences ; vol. 147, 2018, p. 254-267.

69 : Advanced interpretation of gravity data for determining the structural framework : case of Fkirine and Djebibina area (transition between central Tunisian Atlas and Sahel domain, North Africa). MOUAKHAR H., GABTNI H., BEL KAHLA A.

Keywords: Gravity; Qualitative and quantitative; Structural ; Draa Ben Jouder Graben ; Atlas ; Sahel ; Tunisia.

Abstract : The transitional zone between the Atlas Province and the Sahel domain has shown several structural complexities. In order to better understand the structural framework of this zone, a gravity study has been carried out based on a qualitative and quantitative interpretation of gravity data. This study area (Fkirine and Djebibina maps) has indicated that four major tectonic directions underlay the area. We denote NE-SW, NW-SE, E-W, and N-S fault directions. The E-W and N-S strike-slip faults have played a major role in the structuration of the Sahel domain. The depth of E-W faults exceeds 5 km, which explain their deep role in the area structuration. The major thrust front of

Zaghouan has been shown as a discontinuous line, due to the change of the tectonic stress field from the Upper Miocene until the Plio-Quaternary. The change of the compression regime direction from NW-SE to NS during the Plio-Quaternary induced a transtensional movement in Fkirine and Djebibina area that created new depressive structures as Draa Ben Jouder Graben. Applying the gravity method in this area has emerged several information, which are used to better understand the architecture of the region and the impact of faults in the geodynamic evolution.

In : Arabian Journal of Geosciences ; vol. 12, n° 4, 2019, 120-22 p.

70 : New insights on structures and active faults in northeastern Tunisia (Utica-Mateur region) from a gravity analysis : geodynamic implications. RABII F., JALLOULI CH., MICKUS K., SOUMAYA A., REBAI N., BEN AYED N.

Keywords : Gravity anomalies ; Active tectonics; Maghrebides; Northeastern Tunisia.

Abstract : Gravity data were analyzed in conjunction with earthquake, seismic reflection, and geological data to investigate the upper crustal structure of the Utica-Mateur region of northeastern Tunisia and relate this structure to the current tectonic environment of northern Tunisia. To accomplish this goal, gravity anomaly maps were constructed using isostatic gravity residual methods, match-filtering to create residual anomalies, and horizontal gravity gradients. Additionally, the depths to the major density contrasts were determined using a 2D power spectrum analysis and Euler deconvolution and 2D forward modeling. The residual gravity anomalies interpreted in conjunction with gradient determined lineaments indicate that there are several gravity maxima related to uplifted regions bounded by lineaments that trend mainly to northeast- and northwest. Based on the Euler deconvolution analysis, the majority of these lineaments are located at shallow depths (<6 km) and can be related to the seismic activity of the region. Correlating these newly imaged lineaments, uplifts and subsiding areas with seismicity and focal mechanism studies, a new structural map is proposed for the Utica-Mateur region. The majority of the region can be interpreted by uplifts and subsiding (pull apart basins) areas bounded by strike-slip faults that contain compressional and extensional stress components. This stress regime is thought to be caused by the reactivation of older structures by the current compressional stress regime due to the convergent of Africa and Eurasia and active rifting of the Sicily basin. However, the proposed recent segmentation of a northeast-retreating subducting slab under Africa that caused a major lithospheric discontinuity to the south of the Utica-Mateur region added second and third order tectonic variations. These variations modified the stress regime which caused the formation of strike-slip faults and the gravity analysis indicates that the entire Utica-Mateur region is still affected by this stress field change.

In : Journal of African Earth Sciences ; vol. 147, 2018, p. 54-67.

71 : A preliminary study of relationships between thermal conductivity and petrophysical parameters in Hamra quartzites reservoir, Hassi Messaoud field (Algeria). ZERROUKI A.A., GERAUD Y., DIRAISON M., BADDARI K.

Keywords : Thermal conductivity ; Petrophysical parameters ; Cement ; RBF neural network ; Hamra quartzites reservoir ; Hassi Messaoud ; Algeria.

Abstract : The geothermic studies, the thermal conductivity (TC) is an essential parameter needed to calculate heat flow in rocks. It is obtained generally with high accuracy from laboratory measurements. The methodology proposed in this paper is to estimate the TC, which depends on many parameters ; such as mineralogy, porosity, shape of voids and nature of contact between grains, based on linear and nonlinear relationships. In order to predict the thermal conductivity from other petrophysical parameters in the Hamra quartzites reservoir, we have measured porosity, density and permeability, for dry samples taken from core wells. The correlation coefficients (R) were calculated between thermal conductivity and other petrophysical parameters for all samples. The results show that, the correlation coefficient is moderate between TC and the porosity, weak between TC, density and permeability. To improve these correlations, samples were classified into cemented and uncemented sets. A minor improvement on the correlation coefficients is noted between TC, density and porosity in uncemented samples, with values equal 0.51 and 0.73, respectively. The application of Radial Basis Function (RBF) neural networks, using density, porosity and permeability as inputs and thermal conductivity as output, permit us to predict the thermal conductivity with high precision. The correlation coefficient between TC estimated by the RBF neural network is the same as that measured in laboratory equaling 0.983.

In : Journal of African Earth Sciences ; vol. 151 2019, p. 461-471.

72 : Spatio-temporal trends in daily maximum rainfall in northwestern Algeria (Macta watershed case, Algeria). BENZATER B., ELOUISSI A., BENARICHA B., HABI M.

Keywords: Breaking; Climate change; Extreme rainfall; Macta trend; Algeria.

Keywords : Results of extreme precipitation trend analysis, at different spatial and temporal scales, have become alarming since the last century, due to the global climate change. This work describes the impact of climate change on the distribution and trend of maximum daily rainfall in the Macta watershed. Monthly maximum rainfall data that were collected over 41 years (1970 to 2010) on 41 stations were used to validate the present research. The extreme values of rainfall maxima (200 to 264 mm/d) are located in the northeastern part of the basin during the spring season. From 1992 onwards, shifts are observed from monthly, seasonal in addition to significant annual trends. Monthly, seasonal, and annual rainfall maxima trend analyses were identified using three methods, which are Mayer's adjustment method, Sen's innovative method (2012), and the Bravais-Pearson test. The study found out a downward trend during the first period (1970-1992). On the other hand, the second period (1992-2010) revealed significant upward trends. Climate change affects all regions except the center part of the study basin.

In : Arabian Journal of Geosciences ; vol. 12, n° 11, 2019, 370-18 p.

73: Mapping and monitoring soil erosion in a watershed in Western Algeria. BOUDERBALA D., SOUIDI Z., DONZE F., CHIKHAOUI M., NEHAL L.

Keywords: Erosion; GIS; Remote sensing; USLE; Fergoug watershed; North Western Algeria.

Abstract : Fergoug watershed is subject to severe water erosion and land degradation that threaten agricultural sustainability for local populations. Soil loss and degradation by water erosion were estimated using the universal soil loss equation (USLE). The spatial distribution of soil losses was determined using the following parameters : the erosivity factor (R), obtained using climatic data from 12 local stations over a period of 41 years ; the land cover factor (C) , obtained using LandSat-TM satellite imagery 7 and 8 ; the erodibility factor (K), estimated from soil particle size analyses ; and the topographic factor (LS), obtained from a digital terrain model. The Fergoug watershed is characterized by complex topography, and the topographic factor reached a value of 14.29. The erodibility factor K ranged from 0.08 to 0.38, and high values were recorded for about 20% of the watershed. The rainfall erosivity factor R ranged between 212.32 and 146.73 from east to west. The plant cover factor varied inter- and intra-annually from 2.24 in May 2000 to 0.06 in May 2015. As a result, soil losses varied from 0.35 to 617.66 tons per hectare per year (t/ha/year) in a rainy year, and from 0.27 to 1188.92 t/ha/year in a dry year. The combined effects of the slope angle and the vegetation cover were shown to play a major role in soil losses in this area.

In : Arabian Journal of Geosciences ; vol. 11, n° 23, 2018, 744-16 p.

74 : Influence of vegetation cover on the assessment of erosion and erosive potential in the Isser marly watershed in northwestern Algeria-comparative study of RUSLE and PAP/RAC methods. CHIKH H.A., HABI M., MORSLI B.

Keywords: Cartography; Potential erosion; NDVI; RUSLE; PAP/RAC; Algeria.

Abstract : The present article aims to evaluate soil losses due to water erosion and to contribute to the knowledge about the impact of vegetation cover on the Isser watershed that is located in northwestern Algeria. For this purpose, two predictive models were used, namely the Priority Actions Program by the Regional Activity Center (PAP/RAC) model and the revised universal soil loss equation (RUSLE) model, using the geographic information system (GIS). To illustrate the level of protection in that watershed, it was decided to use two approaches for the estimation of factor C ; the first one is the classical method and the second consists of calculating the normalized difference vegetation index (NDVI) during two periods (dry and wet). The map of erosive states, which was obtained from using by the PAP/RAC model, shows the areas that are potentially most vulnerable to erosion and which cover more than 60% of the total area of the basin. The results for vegetation cover (factor C) by the conventional method during the dry period present an average land loss equal to 14 (t ha⁻¹ year⁻¹), whereas this rate decreases to 7.9 (t ha⁻¹ year⁻¹) during the wet period. According to the NDVI approach, the factor C results for the dry season are 25.53 (t ha⁻¹ year⁻¹) with an annual land loss of up to 3 million tons. This study provided the qualitative and quantitative estimates needed for the development of the environmental management; it also helps to control the different impacts on that watershed.

In : Arabian Journal of Geosciences ; vol. 12, n° 5, 2019, 154-23 p.

75 : Geotechnical and mineralogical properties of treated clayey soil with dune sand. AMRI S., AKCHICHE M., BENNABI A., HAMZAOU R.

Keywords : Clay ; Dune sand ; Plasticity ; Swelling ; Treatment ; Geotechnical properties ; Mineralogy ; Algeria.

Abstract : Clayey soils are considered as problematic soils for geotechnical engineering. They are characterized by poor geotechnical properties because of their high plasticity and water absorption properties. The consisting treatment by substituting a fraction of these soils by an inert sand is approached. However, if some conclusions are common to these works, they could not be generalized. Very often, the results obtained depend on the nature and intrinsic properties of the soils considered. The aim of the present study is to investigate clayey soil (from the region of Medea, Algeria) treatment effect by using dune sand on geotechnical, structural and mineralogical properties. Atterberg limits, compaction and unconfined compression tests are performed on clay soil and for mixtures with different dune sand percentages. In addition, triaxial tests and free swelling oedometric tests are carried out on the mixture corresponding to the optimal dune sand content. The mineralogical properties are determined using X-ray diffraction (XRD). X-ray diffraction patterns have showed that the dune sand addition in clay soil introduces only a change in quartz intensity. In addition, it is observed that the treatment provides a substantial improvement in the mechanical properties, especially for the 30% dune sand mixture. Nevertheless, this optimal with 30% dune sand mixture does not solve the problem of swelling, because the latter is important than untreated clay soil.

In : Journal of African Earth Sciences; vol. 152, 2019, p. 140-150.

76 : Simulation of seepage flow through an earthen dam with vertical drain and comparison of results with observations data (case study : harreza dam-Algeria). CHOUIREB M., DJEHICHE A.

Keywords: Seepage analysis; Phreatic line; SEEP/W; Finite element modeling; Earthen dam; Harreza dam; Algeria.

Abstract : Seepage analysis is very important issues that should be considered at designing of an earthen dam. For this purpose, a research study was conducted on Harreza dam, which is an earthen dam located at about 15 km, south-west of El-Khmiss city, Algeria. In the study, the amount of seepage through and under body of the main dam is computed ; profile of phreatic line is simulated for different scenarios and compared with the observed data. For this study, SEEP/W, the sub-program of Geo-Slope software is used. Data pertaining to design parameters and dam geometry are given as input to the software to compute the unknown parameters. Validation of the model is made by comparing simulated results against the observed ones ; this is done to ensure model applicability. The comparison shows a high efficiency and good fitness.

In : Arabian Journal of Geosciences ; vol. 12, n° 13, 2019, 406-7 p.

77 : GIS-based landslide susceptibility assessment using statistical models : a case study from Souk Ahras province, N-E Algeria. MAHDADI F., BOUMEZBEUR A., HADJI R., KANUNGO D.P., ZAHRI F.

Keywords: Slope instability; Landslide-related factors; Logistic regression; Frequency ratio; Weights of evidence; Souk Ahras; N-E Algeria.

Abstract : Slope instability phenomena in Souk Ahras region are annually causing a great amount of damage mainly to road infrastructure, water main supply, and buildings. The main problem is that instabilities keep reoccurring despite the remedial measures brought about every time. The fact is there is not only a single factor that is behind these instabilities rather than the interplay of a large variety of factors pertaining to the geological, geomorphological, and hydrological characteristics of the terrain as well as human related activities. Consequently, a spatial database of ten landslide-related factors were identified and used to assess landslide susceptibility and establish a model capable of predicting landslide prone areas. For this reason, three statistical methods are used for the landslide susceptibility assessment : logistic regression, frequency ratio, and weights of evidence in a GIS platform. A landslide inventory map was established from visual interpretation of satellite images and field survey data. Three landslide susceptibility maps were produced using different statistical models. Each susceptibility map subdivides the study area into five classes of landslide susceptibility : very low, low, moderate, high, and very high. These raster-based susceptibility maps were compared and verified with both training and validating inventory data. The area under the curve values, based on success rate, are between 82.11 and 90.57%, and those based on prediction rate are between 83.14 and 90.91%. The results showed that the logistic regression method is more consistent and reliable than the two other techniques, and it has the best performance among the three statistical methods.

In : Arabian Journal of Geosciences ; vol. 11, n° 17, 2018, 476-21 p.

78 : Seasonal variation in biomarker responses of *Donax trunculus* from the Gulf of Annaba (Algeria): implication of metal accumulation in sediments. AMIRA A., MERAD I., ALMEIDA C.M.R.

Keywords : Mollusk bivalve; Biomonitoring; Glutathione S-transferase; Acetylcholinesterase; Metallothioneins; Pollution; Annaba; Algeria.

Abstract : The aim of the present study was to test biomarker responses in an edible mollusk, *Donax trunculus* L. (Mollusca, Bivalvia) associated with environmental pollution in the Gulf of Annaba (northeastern Algeria). The biomarkers selected were glutathione S-transferase (GST), acetylcholinesterase (AChE) and metallothioneins (MTs). Samples were collected seasonally (September 2014, and January, April and July 2015) from two sites located over the Gulf of Annaba : El Battah and Sidi Salem. The results obtained reveal that autumn and winter were the two seasons that show an increase in GST activity, an inhibition of AChE activity and a high rate of MT.

In addition, a decrease in AChE activity, an increase in both GST activity and MT levels in *D. Trunculus* collected from Sidi Salem in comparison with those of El Battah were observed. The biomarker responses at the Sidi Salem site reflect the presence of certain pro-oxidative compounds such as metals (Cd, Cu, Pb, Zn, Mn and Fe) determined in sediments in winter (January) 2015. Moreover, metal concentrations, except Fe, were higher at Sidi Salem than at El Battah. Overall, the Gulf of Annaba remains contaminated by heavy metal. However, this metallic contamination is relatively low and the risks for local population via this edible species were also low.

In : C. R. Acad. Geoscience; vol. 350, n° 4, 2018, p. 173-179.

79 : Seasonal variation of water quality and phytoplankton dynamics and diversity in the surface water of Boukourdane Lake, Algeria. ARAB S., HAMIL S., REZZAZ M.A., CHAFFAI A., ARAB A.

Keywords: Phytoplankton; Seasonal variation; Trophic status; Boukourdane Lake; Algeria.

Abstract : A study of phytoplankton diversity and its seasonal variation was conducted by sampling water from Boukourdane Lake between February 2013 and January 2015. Fifteen physical and chemical variables were recorded, and their relationship with the density of 162 phytoplankton species was established using Canonical Correspondence Analysis, which showed that the density of phytoplankton was higher when minerals and nutrients increased. An anthropogenic impact was also most evident in structuring phytoplankton assemblages at sites close to the lake where agriculture was concentrated. The results obtained from the Margalef, Shannon-Wiener, and Equitability diversity indices indicated mediocre water quality. Determinations of the trophic state were made by examining several diverse criteria, such as transparency and the concentrations of chlorophyll a and phosphorus. Our study area was characterized as mesotrophic according to the Organisation for Economic Co-operation and Development classification.

In : Arabian Journal of Geosciences ; vol. 12, n° 2, 2019, 29-11 p.

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