COORDINATION COMMITTEE
2015-2020

"MEDYNA"
"MAGHREB-EU INTEGRATED RESEARCH ON GEODYNAMICS, GEOHAZARDS, AND APPLIED GEOLOGY IN NORTH WEST AFRICA"

PROPOSAL

CARLOS J. GARRIDO

INSTITUTO ANDALUZ DE CIENCIAS DE LA TIERRA, CSIC, GRANADA.

JEAN-LOUIS BODINIER

GÉOSCIENCES MONTPELLIER, UNV. MONTPELLIER, FRANCE

TABLE OF CONTENTS

COORDINATION PROGRAMME 3
1.1 Objective and relevance of the joint exchange programme 3
1.1.1 Scientific rationale and context of the research staff exchange programme 3
1.1.2 General objectives of the MEDYNA ILP-CC and institutions involved 4
1.1.3 Timing and international relevance of the proposal 5
1.2 Planned scientific activities and detailed exchange scheme 6
1.2.1 Work Packages 6
1.3 Research quality of the partners 19
1.3.1 Expertise of the partners in the relative scientific field(s) 19
Expertise WP1—Present-day kinematics and Seismic Hazards (T=task) 20
Expertise WP2—Landscape evolution and Paleoclimate (T=task) 21
Expertise WP2—Deep Structures and Mantle Processes (T=task) 22
Expertise WP4—Applied Geology (T=task) 24
1.3.2 Experience of the partners in international cooperation 25
1.4 Complementarities and synergies between the partners 25
2 TRANSFER OF KNOWLEDGE (tok) 26
2.1 Quality and mutual benefit of the transfer of knowledge 26
2.1.1 Programme for the transfer of knowledge between the partners 26
2.1.1.1 Online dissemination, training and discussion platform 26
2.1.1.2 Collaborative Research 27
2.1.1.3 Onsite training 27
2.1.1.4 Programme of Workshops and Meetings 27
2.1.1.5 Joint publications 28
2.1.1.6 Broader-Audience Communication, Dissemination and Outreach Activities 28
2.1.2 Added value for the partners involved 29
3 IMPLEMENTATION 29
3.1 Capacities to achieve the objectives of the planned coordination 29
4 IMPACT 31
4.1 Potential to develop lasting collaboration with eligible Third Country Partners 31

COORDINATION PROGRAMME

1.1 Objective and relevance of the joint exchange programme

1.1.1 Scientific rationale and context of the research staff exchange programme

At the triple junction between the West African Craton, the Atlantic Ocean and the Western Mediterranean Basin, the North-westernmost Africa boundary is characterized by significant seismicity, a rugged topography—including the highest reliefs in northern Africa—long-lasting volcanic activity, and numerous natural resources (Fig. 1a). This geological setting is widely considered as a **unique natural laboratory where interactions between mantle and lithosphere dynamics, crustal extension and compression, subsidence and uplift, can be documented and investigated in great detail** (*1*). This is the reason why it **constitutes the focus site of international integrated Earth Sciences research**—geodynamics, geohazards, genesis of mineral and industrial resources and their industrial application—**that involves many research groups in Europe and Mediterranean Partnership Countries (MPC) such as Morocco, Algeria and Tunisia**.

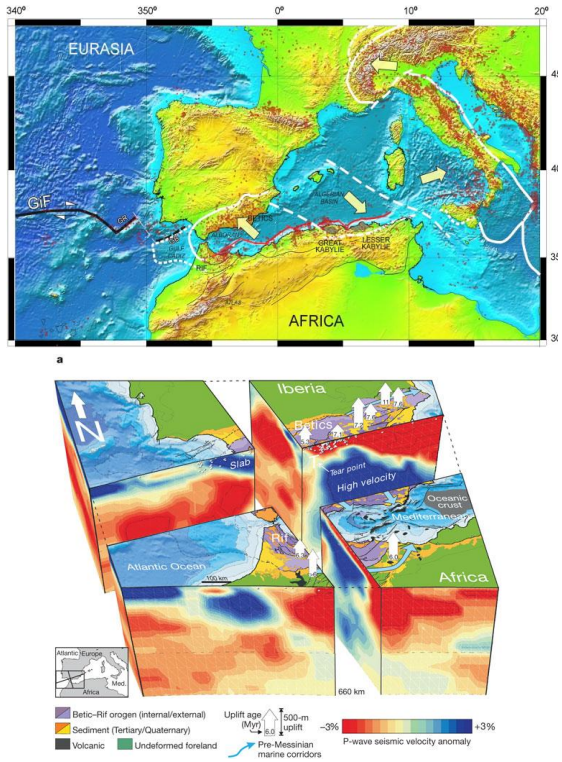

Figure 1. *(a) (upper) Topography, Bathymetry, Plate Structure, Seismicity and Geodetic movements in the westernmost Mediterranean (after 2); (b) (lower) Vertical movements and Mantle Tomography in the Eurasian-African boundary (after 6).*

The NW African margin is characterized by frequent earthquakes (e.g. Al Hoceima, 2004, M> 6.3). Seismicity is present in the "Alpine" Maghreb and extents to the N of the Western African Craton. Although the Geology of the area is well known (*2,3; and references therein*) **the Northern African plate boundary system is paradoxically the least understood segment of the Earth global convergent system**. This largely reflects the intrinsic complexity of the present-day plate boundary, characterized by a diffuse geometry and several lithospheric domains (*3; and references therein*) accommodating the relative motion between Eurasia and Africa (Fig. 1a).

There is a growing body of arguments to consider that the processes that shape the surface of this key area are closely associated with mantle dynamics underneath, and that both processes chiefly reflect near- to far-field effects of the convergence between Africa and Eurasia (Fig. 1b) (*4-7; and references therein*). This complexity partly arises from the fact that surface and deep processes bear the heritage of previous

geodynamic events, including the structuring of continental lithosphere during orogenic events and the effects of later extension in the Atlantic and Alboran system. Furthermore, the topographic variations are affected by external forcing, and the topography and deep processes may also be coupled through feedback interactions *(e.g. 3, 5-7)* (Fig. 1b)**. Further advances in our understanding of the structure and dynamics of this key area—and in societal issues related to geohazards and georesources—require the combined analysis of surface evolution with knowledge on deep structures and dynamics (*1-7*). This scientific challenge necessitates improving the transfer of knowledge and networking of research staff from EU and MPC working in the area on multidisciplinary studies encompassing Geodynamics, Geohazards, and Applied Geology**.

REFERECES CITED: (1) Cloetingh et al., 2008. Preface from the International Lithosphere Program. In Michard et al. (eds) "Continental Evolution: The Geology of Morocco". *Springer*. (2) Michard et al., 2008. In Michard et al. (eds) "Structure, Stratigraphy and Tectonics of the Africa-Atlantic-Mediterranean Triple Junction". *Springer*. p. 395-404. (3) Chalouan, A. & Michard, A. (2004). *Pure and Applied Geophysics* **161**, 489-519. (4) Jolivet, L. & Faccenna, C. (2000). *Tectonics* **19**, 1095-1106. (5) Jolivet et al. (2009). *Earth and Planetary Science Letters* **285**, 198-209. (6) Faccenna, C. & Becker, T. W. (2010). *Nature* **465**, 602-605. (7) García-Castellanos, D. & Villaseñor, A. (2011). *Nature* **480**.3 59-U108.

1.1.2 General objectives of the MEDYNA ILP-CC and institutions involved

The overarching goal of ILP-CC MEDYNA is to create and/or reinforce networks for long-term, joint research projects and high-level training of personnel between European and Maghreb research staff working in the fields of Geodynamics, Geohazards, and Applied Geology in NW Africa. MEDYNA is an ambitious research staff exchange scheme on Integrated Earth Sciences that will promote international collaborations between **4 EU Beneficiaries from Mediterranean EU institutions in Spain, France and Portugal, and 17 Mediterranean institutions from the Partnership Countries (MPC) of Morocco, Algeria and Tunisia** (*qv*. Table 1).

TABLE 1. Research institutions involved in ILP-CC MEDYNA and Lead Scientists

Entity			Laboratories/Institutes/University	Lead Scientist	City/Country	
EU/MS Beneficiaries						
1	CSIC	IACT	Instituto Andaluz de Ciencias de la Tierra (CSIC & UGR)	Garrido (1) Galindo	Granada	ES
2	UM2	GM	Géosciences Montpellier	Bodinier	Montpellier	FR
		ISEM	Institut des Sciences de l'Evolution de Montpellier			
3	CNRS	GNICE	Géoazur Nice (CNRS & Université de Nice SA)	Corsini	Nice	FR
4	UPS	IRAP	Institut de Recherche en Astrophysqiue et Planétologie	Rigo	Tolouse	FR
5	EVORA	CGE	Centro de Geofisica de Évora	Bezzeghoud	Évora	PT
Third Countries Partners (Mediterranean Partnership Countries)						
6	UAE	*	Université Abdelmalek Essaâdi	Targuisti	Tetouan	MA
7	UM5	*	Université Mohammed V-Agdal, Rabat, Morocco.	Chalouan	Rabat	MA

9	UHC2	*	Faculté des Sciences Aïn Chock del' UHC2	Rhazi	Casablanca	MA
10	UCAM	*	Université Cadi Ayyad, Faculté des Sciences Semlalia	Chellai	Marrakech	MA
11	UNIM	*	Université Moulay Ismaïl	Ouali	Meknes	MA
12	UMPO	*	Université Mohammed I	Azdimoussa	Oujda	MA
13	UABB	*	Université Abou Bekr Belkaïd, Faculté des Sciences de la Nature et la Vie et Sciences de la Terre et de l'Univers	Azzouni	Tlemcen	DZ
14	UORAN	*	Université d'Oran	Belaroui	Oran	DZ
15	USTHB	*	Faculté des Sciences de la Terre, de Géographie et d'Aménagement du Territoire de l'USTHB	Ouabadi	Algiers	DZ
16	CRAAG	*	Centre de Recherche en Astronomie, Astrophysique et Géophysique	Ayadi	Algiers	DZ
17	ENSK	*	Ecole Nationale Supérieure de Kouba	Yahiaoui	Algiers	DZ
18	UFAS	*	Université Ferhat Abbas, Institut d'Architecture et des Sciences de la Terre, Département des Sciences de la Terre	Charaf Chabou	Setif	DZ
19	UBMA	*	Université Badji-Mokhtar Annaba	Hammor	Annaba	DZ
20	CNRSM	*	National Center for Research in Material Sciences	Jamoussi	Borj Cédria	TU
21	USFAX	*	Université de Sfax	Kallel	Sfax	TU

1= Coordinator / * = several groups or departments and/or single department institution.

MEDYNA will reinforce existing successful collaborative networks of Mediterranean EU institutions with Maghreb researchers that shared an interested in multidisciplinary Earth Science research with a focus on NW Africa. MEDYNA will provide Maghreb partners with training of a critical mass and profit from educational, technological, industrial and social impact. On the other hand, EU research staff will tap the long standing and unique in-depth knowledge of Maghreb's research staff on the Geodynamics, Geohazards, and Applied Geology of NW Africa. This mutually beneficial research theme will act as a common thread where two-way knowledge will be transferred to staff of all participant institutions. The secondment of EU and Maghreb senior and junior scientists will contribute to the training, improvement of the scientific and education system and to the strengthening links between Maghreb and Europe researchers in the Geodynamics, Geohazards and Applied Geology in NW Africa. Since the actors involved in the proposal (*qv.* Table 1) include some of the most relevant groups working in the area in collaboration with Maghreb's researchers, MEDYNA provides an outstanding framework for transfer of knowledge. **MEDYNA will lay down the foundations and set up tools for sustainable collaboration between EU and Maghreb institutions in the integrated studies of Geodynamics, Geohazards, and Applied Geology, well beyond the end of the project**.

1.1.3 Timing and international relevance of the proposal

At the EU and international level, MEDYNA's researchers participate in several ambitious international Earth Science initiatives combining Geodynamics, Geohazards and Applied Geology as

part of an integrated vision of Earth Sciences Studies in the westernmost Mediterranean and NW Africa. Among these, we highlight the ESF-EUROSCORE TOPO-EUROPE initiative, the ESF-TopoMed project "*Plate re-organization in the western Mediterranean: lithospheric causes and topographic consequences*" that gathers research groups from 7 European countries (France, Germany, Ireland, Italy, The Netherlands, Portugal and Spain), the USA-NSF PICASSO Project ("*Program to Investigate Convective Alboran Sea System Overturn*"), and the Spanish CONSOLIDER-INGENIO TOPO-IBERIA project *("Geosciences in Iberia: Integrated studies on topography and 4-D evolution"*). Furthermore, MEDYNA researchers are the founding partners of the International Lithosphere Program Coordination Committee MEDYNA: "*Mantle Dynamics and Plate Architecture beneath North Africa*" (PIs Garrido & Bodinier), and are involved in the TerMEx White Paper ("*Terra-Mediterranean Earth Science Experiment*"), in the frame of the French MISTRALS initiative ("*Mediterranean Integrated Studies and Regional And Local Scales*"). MEDYNA participants also contribute to several Work Packages of The European Plate Observing System (EPOS), an integrated solid Earth Sciences research infrastructure approved by the European Strategy Forum on Research Infrastructures (ESFRI) and included in the ESFRI Roadmap aimed promoting innovative approaches for a better understanding of the physical processes controlling earthquakes, volcanic eruptions, unrest episodes and tsunamis as well as those driving tectonics and Earth surface dynamics, and use of the multidisciplinary data recorded by the solid Earth monitoring networks, acquired in laboratory experiments and/or produced by computational simulations.

Despite these initiatives there is a consensus that Earth Science research in the area is fragmented due to the lack of a multilateral and sustainable transfer of inter- and trans-disciplinary knowledge between EU and Maghreb researchers. The MEDYNA ILP-CC is aimed at filling this gap by fostering the transfer of knowledge through a 4 year programme of research staff exchange as an essential step forward to lay the foundations for a sustainable collaboration network on integrated Earth Science studies between EU and Maghreb institutions.

1.2 Planned scientific activities and detailed exchange scheme

1.2.1 Work Packages

The MEDYNA's **Work Packages (WPs)** structure is aimed at strengthening the research partnerships and foster synergies among MEDYNA partners through focus-site multidisciplinary, integrated Earth Sciences studies. In addition, it provides an appropriate framework for the transfer of knowledge activities that can be tracked and monitored efficiently to assess the advance status of the project. **Table 2** shows the list of **Work Packages (WP)** involved in the MEDYNA for the 48 months of duration of the exchange scheme.

TABLE 2. List of Work Packages

WP	Work Package Title	Partner/Beneficiary*	Start	End
1	Present-day kinematics and Seismic Hazards	1, 2, 4, 5, 6, 8, 16	1	48
2	Landscape Evolution and Paleoclimate	1, 3, 6, 7, 9, 10, 11, 12, 13, 21	1	48
3	Deep Structures and Mantle Processes	1, 2, 6, 7, 11, 13, 15, 17, 19	1	48
4	Applied Geology	1, 2, 6, 10, 11, 13, 14, 15, 18, 20	1	48
5	Transfer of Knowledge, Dissemination & Outreach	All	1	48
6	Management & Coordination	All	1	48

(*) Participant number (*cf.* Table 1)

According to the prior knowledge by participants, the scientific activities of the exchange scheme will be grouped **into 4 Work Packages (WP1-4)** with a **research-focus around which the staff exchanges and networking activities will take place**. WPs 1-3 are multidisciplinary and include disciplinary or cross-disciplinary tasks. They will tackle **four prominent and complementary aspects of the geodynamic interactions between tectonic plates and convecting mantle in NW Africa**. The **WP4** is devoted to increase the synergies among multidisciplinary studies to investigate the origin of georesources **in close connection with WPs1-3**, and **use of these georesources for societal and industrial applications**. Two **supplemental WPs on "Transfer of Knowledge, Dissemination & Outreach" (WP5)** and **"Management & Coordination" (WP6)** will warrant the success and sustainability of the ILP-CC.

In the following Tables we describe for each WP its objectives, tasks, deliverables and researchers involved in the exchange scheme.

1.2.1.1 Table 3.1— Work Package 1: "Present-day kinematics and Seismic Hazards"

WP	**1**	**Start date :**	**Month 1**
Work Package Title :		**Present-day kinematics and Seismic Hazards**	
Beneficiary/Partner :		**1, 2, 4, 5, 6, 8, 16**	

Objectives

To better quantify and understand the present day kinematics and seismic hazard in NW Africa through multidisciplinary studies combining geodesy, morphotectonic and seismicity.

Description of work (T = Task):

T1.1 ***Geodesy:*** In October 2011 MEDYNA researchers installed and surveyed 16 new SGPS sites in the study area (focus on N. Morocco). We resurvey these and older GPS sites. The 3-4 years duration of the observation will be sufficient to determine reliable site velocities with uncertainties of ~1 mm/yr (global) and ~0.4 mm/yr (regional), and to start estimating vertical motions. All the results will be integrated with those of other international colleagues working in the area.

T1.2 ***Morphotectonic:*** Field studies will focus on the deformation zones as defined by the GPS velocity field. We shall use kinematic GPS and/or total stations together, as well as dating methods (in-situ ^{3}He & 1^{0}Be, OSL, ^{14}C), to estimate and date displacements of offsets markers. In particular, we plan to carry out a detailed morphotectonic study along faults preserving outstanding left-lateral/normal displacement within an alluvial terrace. There, DEM of the area and detailed geological mapping, combined with in-situ ^{3}He & ^{10}Be dating of the offset terrace should allow us to determine precisely the kinematics of the fault (strike, dip, rake and slip rate) and the recurrence intervals of earthquakes.

T1.3 ***Seismicity and Seismic Hazards:*** We will precisely analyze the instrumental seismicity recorded through collaborations already established. This new analysis will take advantage of the results issued from the TopoIberia and PICASSO campaigns, especially in giving a more precise seismic wave velocity model at lithospheric scale. In that way, we will reduce the location inaccuracies of the crustal seismicity and will constrain better the rupture mechanisms. In a second stage, we will set up temporary seismological surveys east and west of the Rif-Tell belt. This will allow to study the seismicity in relationship with the observations of Tasks 1.1 and 1.2 and to characterize the tectonic structures governing the bloc kinematics and dynamics in the area.

Researchers involved

IACT-CSIC-UGR (Booth-Rea; Galindo-Zaldivar; Pedrera; Ruano; Ruiz-Constan); **UM2** (Mazzotti; Vernant,); **UPS** (Rigo); **UEVORA** (Bezzeghoud; Caldeira); **UAE** (Mourabit); **CNRST** (Tahayt, ER48; ESR14); **CRAAG** (Ayadi).

Coordination of the Work-Package

Beneficiary & Participant Organisations	CSIC, UM2, EVORA, UAE, UM5, CRAAG
WP-1	Head of working group
Present-day kinematics and seismic hazards	Abdel Hakim Ayadi (CRAAG) & Jesus Galindo (UGR-CSIC)
Task 1.1: Geodesy	Philippe Vernat (UM2) & Mourabit Taoufik (UAE)
Task 1.2: Morphotectonic	Jean François Ritz (UM2) & Maouche Said (CRAAG)
Task 1.3: Seismicity and Seismic Hazard	Alexis Rigo (UM2) , Abdelilah Tahayt (UM5) , Harbi Assia (GRAAG) , Bento Caldeira (Evora)

1.2.1.2 Table 3.2—Work Package 2: "Landscape Evolution and Palaeoclimate"

WP	**2**	**Start date :**	**Month 1**
Work Package Title :		**Landscape evolution and Paleoclimate**	
Beneficiary /Partner :		**1, 3, 6, 7, 9, 10, 11, 12, 13, 21**	

Objectives

Understand the processes that have shaped the actual landscape and its recent evolution (Tertiary-Quaternary) in NW Africa, including the exhumation/denudation history, paleo-stress/strain field and basins evolution, and the reconstruction of extreme climate events at millennium scales.

Description of work (T = Task)

T2.1 ***Kinematics and timing of the major tectonic structures:*** Determine the kinematics and timing of the major tectonic structures associated with the South-Alboran African margin evolution. In particular, the $^{40}Ar/^{39}Ar$ dating method on synkinematic white micas allows determining precise ages of shear-zones deformation under low temperature conditions. We will combine structural, petrological and geochronological approaches to constrain the tectonic evolution and uplift processes in the Rif-Tell Belt since Miocene. This will include: (i) detailed mapping and structural analysis along selected N-S and E-W cross sections to identify the recent fault systems and related stress field; (ii) petrological studies of the main mylonitic zones to quantify the vertical displacements associated with the evolution of the tectonic structures; and (iii) ^{40}Ar-^{39}Ar laser probe dating via step heating of neoformed phengite and gouges from LT shear zone to constrain the timing of exhumation.

T2.2 ***Exhumation history of the Rif-Tell Belt:*** We will carry out AHe and AFT dating on samples from the different structural units of the metamorphic basement, in order to evaluate the possible differences in their exhumation histories. Preliminary results have already been obtained but are restricted to the Alboran domain. The aim of this approach is to identify the major tectonic contacts controlling the exhumation and the importance of tectonic inheritance. The recent exhumation associated with the South-Alboran Africa margin formation will be approached by studying profiles roughly perpendicular to the coastline. Detrital thermochronology will be applied locally on "post-thrust" sediments to quantify Neogene exhumation rates of their sources.

T2.3 ***Basin Analysis: (i) Analysis of subsidence/uplift processes in Neogene basins:*** Constrains the vertical motions that have occurred during the last 10 Ma using basin analysis, notably the Neogene subsidence and the Pleistocene to recent uplifts. The subsidence history will be estimated by combining sedimentological and paleobathymetric changes in accurate chronological frames constrained by ^{40}Ar-^{39}Ar dating of volcanic ash layer and planktonic calcareous biostratigraphy; (ii) ***Investigation of late Cretaceous-Paleogene basins:*** Constrain the origin and paleo-environmental conditions of basins through detailed sedimentological, structural and geochemical studies in close association with Task 4.1.

T2.4 ***Palaeoaltitude reconstruction of the Rif Mountain:*** To reconstruct the palaeoaltitudes of the Rif Mountain at different time-slices since 10 Ma from pollen data sampled in the same Neogene sedimentary basins. Palynology is an excellent tool for palaeoaltitude estimates since the sedimentary basins receive from surrounding reliefs, along with detritic inputs from rivers, a large amount of pollen grains representative of all vegetation belts of the catchment area. The palaeoaltitude reconstruction method established by MEDYNA researchers takes into account pollen floras expanded near the coastline, the modern distribution of plants, palaeotemperature estimated at low altitude using the "Climatic Amplitude" method and a standard relationship between the latitudinal and altitudinal thermic gradients. Our preliminary works performed on the Nador borehole has demonstrated the feasibility of this approach in northern Morocco. These reconstructions require the calibration of sub-modern pollen data vs. altitude estimates. Sub-modern pollen data will be sampled at different altitudes in the Rif. The pollen sequences obtained from these sites will allow reconstructing the natural (before human impacts) vegetation as we are used to and the climate altitudinal gradients for recent times (<10,000 years). Moreover, a series of surface samples taken along the altitudinal gradient will also be analyzed. All these data, both from Holocene sequences and modern samples, will constitute a valuable basis for Neogene vegetation and palaeoaltitude reconstructions.

T2.5 ***Constraining Western Mediterranean extreme floods and storms during the last millennium***: There is an increasing concern that extreme climatic events may be changing in frequency and intensity in the context of future climate change. Storms and floods have long been a threat for the western Mediterranean coast but their link with climate variability is not well understood. This is part due to the fact that extreme events are inherently rare and difficult to observe in the period of a human life and to the lack of long-term observations or palaeo-reconstructions. This task will focus on the western Africa Mediterranean coastal region (i.e. Morocco-Tunisia) that are particularly sensitive to erosion/submersion during storm events and have societal issues in terms of flood risks. It will combine palaeo-data and model simulations to (i) document the occurrence of extreme events (floods and storms) that have impacted selected lagoon sites of the western Mediterranean during the last millennium, (ii) investigate the relationship between these events and climate variability and trends; and (iii) compare reconstructed climatic series to simulations realized on the coupled climatic models (e.g., ARPEGE-NEMO, IPSL) to investigate the mechanisms triggering extreme events and to develop future scenarios simulations to tentatively assess the extreme floods and storms probabilities in the future.

Researchers involved

IACT-CSIC-UGR (Booth-ReA; Galindo-Zaldivar; Jabaloy; Jiménez-Moreno; Pedrera; Ruano; Ruiz-Constan; Sanz de Galdeano); **UM2** (Bodinier; Chauvet; Corné; Dezileau,; Fauquette,; Labaume,; Marivaux,; Merzeraud,; Muller; Münch; Séranne; Tabuce); **CNRS-GN** (Corsini; Lardeaux; Vérati); **UAE** (Ben Moussa); **UM5** (Asebriy,; Chalouan; Snoussi); **UHC2** (Rhazi); **UCAM** (Chellai; Feddi); **UNIM** (Badra); **UABB** (Adaci D; Adaci M; Bensalah); **USFAX** (Kallel).

Coordination of the Work Package

Beneficiary/Participant Organisations	CSIC, UM2, CNRS, UAE, UM5, UHC2, UCAM, UNIM, USFA
WP-2	Head of working group
Landscape evolution and paleoclimate	**Ali Azdimoussa (UMPO)** & **Philippe Münch (UM2)**
Task 2.1: Kinematics and timing of the major tectonic structures	Ahmed Chalouan & Michel Corsini (CNRS)
Task 2.2: Exhumation history of the Rif-Tell Belt	Ali Azdimoussa (UMPO) , Philippe Münch (UM2) , Antonio Jabaloy (UGR-CSIC)
Task 2.3: Basin Analysis: (i) Analysis of subsidence/uplift processes in Neogene basins (ii) Investigation of late Cretaceous-Paleogene basins	Abdelkhalek Ben Moussa (UAE) , Mustapha Bensalah (UABT) , Jean Jacques Cornée (UM2) , José Fernando Borges (UEVORA) , Mohamed Marzoqí (UCAM)
Task 2.4: Paleolatitude reconstruction of the rift Mountain	Séverine Fauquette (UM2) & Laila Rhazi (UHC2)

Task 2.5: Constraining Western Mediterranean extreme floods and storms during the last millennium	Laurent Dezileau (UM2) , Maria Snoussi (UM5) , Néjib Kallel (SFAX).

1.2.1.3 Table 3.3—Work Package 3: "Deep Structures and Mantle Processes"

WP	**3**	**Start date :**	**Month 1**
Work Package Title :		**Deep Structures and Mantle Processes**	
Beneficiary /Partner :		**1, 2, 6, 7, 11, 13, 15, 17, 19**	

Objectives

Constrain the composition, structure and dynamic of the shallower asthenospheric mantle and lithosphere combining complementary disciplines (seismology, petrophysics, volcanology, petrology, geochemistry and geochronology) and observations at different temporal and spatial length-scales to unravel the tectonomagmatic evolution and deep processes responsible for the current topography, high heat flow, and gravity and geoid anomalies in many areas of NW Africa.

Description of work (T = Task)

T3.1 ***Geophysical imaging of deep mantle and lithospheric structures:*** Asthenospheric upwelling and/or channeling have been suggested for the Atlas range on the basis of topography and geoid anomaly, but direct observations of the mantle seismic velocity structures and seismic anisotropy are still missing. Ongoing international campaigns (e.g. PICASSO, Maroko-Münster) will partly fill this gap, but the central part of Morocco remains poorly instrumented and therefore the so-called "Moroccan Hot Line" will not be well documented. With an enlarged CNRST-ING seismic station network, we will determine the Moho, lithosphere-asthenosphere boundary and transition zone thicknesses with P and S receiver functions, constrain the upper mantle flow with SKS splitting analysis, and investigate the rheological and thermal structure of the lithosphere with coherence and admittance analyses. We will compare the predicted thermal structure with geotherms deduced from mantle xenoliths and seismic determinations of the LAB depth and compared with the seismic velocity from seismic tomography models with the aim of discriminating between thermal and compositional anomalies. In addition, in this task we will use, among others, gravity, magnetics and magnetotelluric prospecting at different length-scales to provide additional constrains on the structure of the lithosphere and shallowest asthenosphere that will be used to investigate mechanisms of orogeny at different temporal scales.

T3.2 ***Mantle rocks as windows into mantle lithospheric thinning processes:*** Tectonically emplaced peridotite massifs and mantle xenoliths brought up by basaltic volcanism convey valuable information on the mechanisms involved in lithospheric thinning. Exposures of subcontinental peridotite massifs in the Rif (e.g., Beni Bousera peridotite massif, N. Morocco) and Tell (e.g., Edough and Collo peridotite massif, N Algeria) preserve a unique record of the tectono-magmatic mantle processes associated with the Tertiary construction of these orogenic belts, and the tectonic processes responsible of its exhumation. On the other hand, mantle xenoliths brought up to the surface by volcanism provide a snapshot of the composition and structure of the mantle beneath volcanic centers at the time of eruption, providing complementary information and a unique temporal record of its evolution. Mantle xenoliths in alkali basalts furnish information on mantle deformation and fluid/melt processes responsible for lithospheric thinning along the "Hot Lines and Spots" in Morocco and Algerian belts around the West African Craton. We will perform an integrated, multi-disciplinary (petrophysics, petrology and geochemistry) study of these rocks to provide constraints on the composition, thermal structure and deformation history of the upper mantle. This study will provide new clues to understand how a combination of thermal, deformation and fluid-rock processes may change the composition and physical properties of the upper mantle and facilitate its convective erosion, in close connection with the aims of tasks in WP1.

T3.3 ***Investigating Volcanism to constrain the recent geodynamic evolution and deep mantle composition*****:** Constrain the nature and origin of the Neogene volcanism and its significance in terms of geodynamic reconstruction from samples the northern part Rif-Tell-Tunisia to the southern, Anti-Atlas through the central, Middle Atlas in Morocco and similar hinterland in Algeria. An extensive multi-method, geochemical study (major, trace and volatile elements, and radiogenic isotopes) will be combined with detailed petrological investigations and absolute dating ($^{40}Ar/^{39}Ar$ and K/Ar). This approach will enable us to determine the sources of the magmatic systems, their potential evolution through time, the pre-eruptive conditions of the magmas – with inference for the depth of the lithosphere-asthenosphere transition. The lavas will also complement the information retrieved from mantle xenoliths (Task 3.2) regarding melt/fluid-rock interactions at base of the lithospheric mantle. This layer, the lower section of the "tectosphere", is now widely considered to play a key role in the (de)coupling between tectonic plates and convecting mantle. Combined with seismological and geophysical imaging, these data will provide constraints to evaluate the proposed geodynamic scenarios.

T3.4 ***Metamorphic and magmatic evolution of the NW African margins and hinterlands***: This task will investigate the magmatic and metamorphic evolution of Rif-Tell belt and the pericratonic tectono-metamorphic terrains in Algeria and Morocco hinterlands to provide a better idea of the processes that have structured the lithosphere in these areas where sealed tectonic sutures have accreted different lithospheric sections and shape lithospheric structure that might have influence the current shaping of and magmatic activity in connection with other task in this WP and in WPs 1-2. This task will comprise structural, metamorphic geology and geochronological and geochemical studies of selected areas where MEDYNA researchers are currently working.

Researchers involved

IACT-CSIC-UGR (Aerden; Galindo-Zaldivar; Garrido; Jabaloy; Pedrera; Ruano; Ruiz-Constan; Sanz de Galdeano); **UM2** (Alard; Bodinier; Bosch; Bruguier; Cenki-Tok; Parat; Tibéri; Tommasi); **UAE** (Amri; Benmakhlouf; Targuisti): **UM5** (Belhassan; Chalouan); **UNIM** (El Maz; Ouali); **UABB** (Azzouni, ER59; ESR18); **USTHB** (Amine-Boukhedimi; Bendaoud; El Khaznadji Riad; Louni; Ouzegane); **ENSK** (Adjerid; Khéloui,; Yahiaoui); **UBMA** (Hammor).

Coordination of the Work Package

Beneficiary/Participant Organisations	CSIC, UM2, UAE, UM5, UNIM, UABB, USTHB, ENSK, UBMA
WP	Head of working group
Deep structures and mantle processes	Abderrahmane Bendaoud (USTHB) & Jean Louis Bodinier (UM2)
Task 3.1: Geophysical imaging of deep mantle and lithospheric structures	Yelles-Chaouche Abdelkarim (GRAAG +UMV) Jesus Galindo Zaldivar (CSIC-UGR)
Task 3.2: Mantle rock as windows into mantle lithospheric thinning processes	Delphine Bosch (UM2) , Dalila Hammor (UBMA) Mohamed Talbi (USTHB) , Kamal Targuisti (UAE)
Task 3.3: Investigating Volcanism to constrain the recent geodynamic evolution and deep mantle composition	Abla Azzouni (UABT) , Houssa Ouali (OMI) Fleurice Parat (UM2)
Task 3.4: Metamorphic and magmatic evolution of	Abderrahmane Bendaoud (USTHB) , Khadidja Ouzegane (USTHB) , Bénédicte Cenki-Tok (UM2)

the NW African margins and hinterlands	Antonio Acosta Vigil (CSIC-UGR) , Youbi Massrredin (UCAM), Mohamed Belhassan (UMV)

1.2.1.4 Table 3.4—Work Package 4: "Applied Geology"

WP	**4**	**Start date :**	**Month 1**
Work Package Title :		**Applied Geology**	
Beneficiary /Partner :		**1, 2, 6, 10, 11, 13, 14, 15, 18, 20**	

Objectives

Increases the synergies among multidisciplinary studies to investigate the origin of key mineral economic resources in NW Africa, and investigate new use of natural geomaterials for societal and industrial applications.

Description of work (T = Task)

T4.1 ***Phosphate Economic Deposits in Late Cretaceous to Eocene epicontinental basins:*** This task will address the origin of the largest phosphate deposits resources of the world found in Morocco. We will investigate: (i) why these basin record very slow detrital inputs (only ±100m during 30 Myr) despite the large uplift of nearby continental source during the formation of these basins. This research will be done in collaboration with researchers tasks WP1-3; (ii) characterize the stratigraphy and structural distribution of dissolution structures to improve our understanding of phosphate deposition and improve the mining and exploration of the deposits; (iii) the geochemistry of phosphates that is very diverse and enriched in trace elements such as strategic Rare Earth Elements. This would allow a better estimate of these strategic elements, and other valuable elements at the scale of basins, sedimentary sequences, lithological facies and samples, including element speciation in solid phases. Geochemical fingerprinting will allow a better understanding of the processes involved in the origin of this enigmatic economic deposit.

T4.2 ***Fluids and tectonics related to the genesis of economic deposits****:* This task will explore some key resources formed by the interaction of fluids formed during orogenic processes that have given place to hydrothermal ore deposits and how they are related to deep processes.

T4.3 ***Industrial applications of geomaterials***: Volcanic activity and basin evolution associated with the geodynamic evolution of NW Africa has formed important and diverse resources of clay-group minerals of great industrial interest. This task will investigate the new industrial uses of these geomaterials as a way to increase the economic value of these natural resources as a mean to increase the capacities of MPC. We will investigate the use of special clays (magnesium sepiolite, palygorskite, smectite, etc.) in applications in pharmacy, thalassic therapy SPA,

manufacturing lightweight aggregates, ceramic manufacturing, manufacturing of ceramic membranes, and manufacture of glasses from quartz. Synergies with researchers involved WP2 will allow a better understanding of geological conditions of specific clays of industrial interest.
Researchers involved **IACT-CSIC-UGR** (Garrido; López-Galindo); **UM2** (Bodinier; Chauvet; Labaume; Marivaux; Merzeraud, ER24; Séranne; Tabuce); **UAE** (Amri; Targuisti); **UCAM** (Chellai); **UNIM** (Badra); **UABB** (Adaci D; Adaci M; Bensalah); **UORAN** (Setti-Belaroui; Mokari); **USTHB**); **UFAS** (Chabou) **CNRSM** (Jamousi).

Coordination of the Work Package

Beneficiary/Participant	CSIC, UM2, UAE, UCAM, UNIM, UABB, UORAN, USTHB, UFAS, CNRSM
WP	Head of working group
Applied Geology	Fakher Jamoussi (CNRSM) & Michael Séranne (UM2)
Task 4.1: Phosphate economic deposits in late cretaceous to Eocene epicontinental basins	Hassane Chellai (UCAM) , Michael Séranne(UM2) , Rabah Laouar (UBMA)
Task 4.2: fluid and tectonic related to the genesis of economic deposits	Lakhlifi Badra (UNIM) , Moulley Charaf Chabou (UFAS) , Alain Chauvet (UM2) , Fernando Gervilla (CSIC-UGR)
Task 4.3: Industrial applications of geomaterials	Alberto Lopez Galindo (CSIC) , Lala Setti Belaroui (UORAN) , Walid Hajjaji (CNRSM)

1.2.1.5 Table 3.5—Work Package 5: "Transfer of Knowledge, Dissemination & Outreach"

WP	**5**	**Start date :**	**Month 1**
Work Package Title :		**Transfer of Knowledge, Dissemination & Outreach**	
Beneficiary /Partner :		**All**	

Objectives

To design and manage an online system for sustainable collaborative research, Transfer of Knowledge (ToK), and dissemination of MEDYNA research. To disseminate the results to the research community, the general public, and to industrial and political stakeholders at the regional, national and EU-Maghreb level, maximizing the benefit of this action for long term cooperation beyond the end of the project.

Description of work (T = Task)

T5.1 ***Online system:*** design, management and optimization of the MEDYNA online system, including conference video repository, links to open access document in, mailing lists, and the WPs' subareas and wiki and specific areas for outreach.

T5.2 ***On-site line research training session researchers:*** design and development of training documentation assembling the WP documentations and adding new material to improve readability and usage.

T5.3 ***Organization of Workshops:*** Organization of bi-annual MEDYNA workshops and sessions at leading international conferences.

T5.3 ***Outreach activities.***

Researchers involved

Lead Scientists (*cf.* Table 1)

1.2.1.6 Table 3.6—Work Package 6: "Management & Coordination"

WP	**6**	**Start date :**	**Month 1**
Work Package Title :		**Management & Coordination**	
Beneficiary /Partner :		**All**	

Objectives

To keep the project on track with respect to the overall objectives and in time with respect to the approved schedule; Find solutions for any deviations from the project plan; Execution, governance, supervision and assessment of the network.

Description of work (T = Task)

T6.1 ***Project Management***: Coordinate the project and manage the work flow; Keep the project on schedule; Handle liaison with the Commission; Manage project risks and contingency plans; Facilitate communication between all members of the consortium; Organize regular meetings of the Supervisory Board.

T6.2 ***Financial and IPR management:*** Arrange collection of financial returns and cost statements; Ensure that resources are deployed as planned; Manage IPR issues, disputes or disagreements between partners. **T6.3** ***General supervision of staff exchanges***: Supervise and keep track of researcher exchanges; Adopt all mechanisms to guarantee that appointed researchers work in a comfortable environment and that exchanges are carry out.
Researchers involved Members of the Network Coordination Team

1.3 Research quality of the partners

1.3.1 Expertise of the partners in the relative scientific field(s)

The expertise of the researchers of the 21 MEDYNA participant institutions is summarized in Table 6. MEDYNA combines trans- and multidisciplinary world leading expertise in the 27 research fields covering most of the Solid Earth Science areas of Geodynamics, Geohazards and Applied Geology. It also brings transdisciplinar expertise in **Paleoecology, Extreme Climate Events and (Geo)Material Sciences**. Arguably a missing research field is Computational Geodynamics; the lack of permanent staff with this expertise in MPC countries makes it difficult secondments in this field; however, this expertise is widely available in several EU beneficiary institutions (CSIC, UM2, CNRS-GN and UPS) and training/collaboration in this domain will be available for MPC staff.

Table 6. Summary of cross- and trans-disciplinary expertise of MEDYNA participant institutions

Expertise	WP n°	Beneficiaries					MPC Partners														
		CSIC-UGR	UM2	CNRS-GN	UPS	EVORA-IGE	UAE	UM5	CNRTS-ING	UHC2	UCAM	UNIM	UMPO	UABB	UORAN	USTHB	CRAAG	ENSK	UFAS	UBMA	CNRSM	USFAX
Geodesy	*1*	■	■		▒		■		■								■					
InSAR	*1*		■	■			■		■													
Morphotectonics	*1*	■	■	■																		
Seismicity	*1*				■	■			■								■					
Seismic Hazards	*1*	▒		▒	■	■			■								■					
Tectonics & Strutural Geol.	*2,3,4*	■	■	■			■	■			■			■		■		■	■	■		
Neo and Active Tetonics	*2*	■	■	■			■	■					■	■		▒						
Thermochronology	*2,3,4*		■	■			■	▒														
Geomorphology	*2*	■	▒	■									■									
Bassn Analysis	*2,4*		■	■			■				■		■	■		▒						
Sedimentology	*2,4*		■				■				■			■		▒						
(Micro)Paleontology	*2,4*	▒	■	■	▒									■								
(Paleo)-climatology-altitude	*2*	■	■							■	■											▒
Extreme Climate Events	*2*		■							■												■
Palynology & Paleoecology	*2*		■							■	■											▒
Seismic Imaging	*1, 2*		■	▒					■								■					
Magnetotellurics	*2*	■	▒						▒								▒					
Other Geophysical methods	*3*	■	▒						▒								■					
Mantle Petrology & Geoch.	*3*	■	■				■	▒				■		■				■		■		▒
Petrophysics	*3, 4*	▒	■									▒				■						
Petrology (Ign. & Metam.)	*2, 3, 4*	■	■	■			■				■		■	■		■		■	■	■		
Volcanology		▒	■									■		■				■	■	■		
Thermodynamics	*2,3, 4*	■	■	▒				■														
(Isotope) Geochemistry	*2, 3, 4*	▒	■	▒										■		■		▒		■		
Geochronology	*2, 3, 4*	▒	■	■									▒	■		■		■		■		
Mineral and Ore deposits	*4*	■	■				■				■	■		▒	▒	▒			■	▒		
Applied Mineralogy	*4*	■					▒				▒	▒		▒						▒		
Geomaterials	*4*	■										▒			■						■	

Black = Primary expertise related to tasks and secondments; Dark gray= available at institution

MEDYNA participant institutions are renowned at the national and/or international level in one or several of the above research fields, and/or in regional geological studies of NW Africa. The quality of their research and expertise in these Earth Sciences disciplines is demonstrated by numerous research projects and scientific publications in leading Solid Earth Science journals (> 200 ISI journal publications in the last 5 years) by MEDYNA researchers. Below, we provide some selected publications that substantiate the institutional and individual expertise, and provide an idea of the international excellence of researchers participating in each of the MEDYNA's Work Packages (the last **name of participant ERs** are listed in the Work Package Tables).

Expertise WP1—Present-day kinematics and Seismic Hazards (T=task)

T.1.1_Koulali, A., D. Ouazar, A. **Tahayt** R. W., King, P. **Vernant, R**. E. Reilinger, S. McClusky, T. **Mourabit**, J. M. Davila, and N. Amraoui 2011. New GPS constraints on active deformation along the Africa–Iberia plate boundary, *Earth and Planetary Science Letters*, *308*, 211-217.

T.1.1_**Vernant**, P., Fadil, A., **Mourabit**, (2010). Geodetic constraints on active tectonics of the Western Mediterranean: Implications for the kinematics and dynamics of the Nubia-Eurasia plate boundary zone. *J. Geodynamics* **49**, 123-129.

T.1.1_**Vernant** et al. (2004). Present-day crustal deformation and plate kinematics in the Middle East constrained by GPS measurements in Iran and northern Oman. *Geophys. J. Int.* **157**, 381-398.

T.1.2_Azañon, J. M., Perez, Giaconia, F., **Booth-Rea,** G. et al. (2012). Active tectonics in the central and eastern Betic Cordillera through morphotectonic analysis: the case of Sierra Nevada and Sierra Alhamilla. *Journal of Geology* **38**, 225-238.

T.1.2_**Pedrera**, A., **Ruiz-Constan**, A., **Galindo-Zaldivar**, J., **Chalouan**, A., **Sanz de Galdeano,** C., **Ruano**, P., **Benmakhlouf**, M. et al. (2011). Is there an active subduction beneath the Gibraltar orogenic arc? Constraints from Pliocene to present-day stress field. *Journal of Geodynamics* **52**, 83-96.

T.1.2_**Galindo-Zaldívar**, **A. Chalouan,** O. Azzouz, C. **Galdeano**, F. Anahnah, L. Ameza, P. **Ruano**, A. **Pedrera**, A. **Ruiz-Constán**, C. Marín-Lechado, M. **Benmakhlouf**, et al. (2009) Are the seismological and geological observations of the Al Hoceima 2004 earthquake (M=6.3) contradictory? Tectonophysics. 475, 1, 59-67

T.1.3_Buforn, E., **Bezzeghoud, M.**, Udias, A. & Pro, C. (2004). Seismic sources on the Iberia-African plate boundary and their tectonic implications. *Pure and Applied Geophysics* **161**, 623-646.

T.1.3_**Caldeira**, B., Silva, H. G., Borges, J. F., Tlemcani, M. & **Bezzeghoud, M.** (2012). Chaotic behavior of seismic mechanisms: experiment and observation. *Annals of Geophysics* **55**, 57-62. 10.4401/ag-5359.

T.1.3_**Ayadi**, A. et al. (2008): M. Zemmouri earthquake rupture zone (M_w 6.8, Algeria): Aftershocks sequence relocation and 3D velocity model, J. Geophys. Res., **113**, B9, 2156-2202.

T.1.3_Lin, J., Stein, R. S.; Meghraoui, M.; Toda, S.; **Ayadi**, A. et al. (2011). Stress transfer among en echelon and opposing thrusts and tear faults: Triggering caused by the 2003 M-w=6.9 Zemmouri, Algeria, earthquake. *J. Geophys. Res.*, **116**, B03305.

T.1.3_**Tahayt**, A., Feigl, K. L., **Mourabit**, T., **Rigo**, A. et al. D. 2009. The Al Hoceima (Morocco) earthquake of 24 February 2004, analysis and interpretation of data from ENVISAT ASAR and SPOT5 validated by ground-based observations. *Remote Sensing of Environment* **113**, 306-316.

T.1.3&2.5_Maouche, S.; Morhange, C.; Meghraoui, M., (2009). Large boulder accumulation on the Algerian coast evidence tsunami events in the western Mediterranean. *Marine Geology, **262**, 96-104.*

Expertise WP2—Landscape evolution and Paleoclimate (T=task)

T.2.1_Chalouan, J. **Galindo-Zaldivar**, M. Akil, C. Marin, A. Chabli, P. **Ruano**, K. Bargach, C. **Galdeano**, M., M. et al. (2006) - Tectonic wedge escape in the southwestern front of the Rif Cordillera (Morocco) (2006). In: MORATTI, G. & **CHALOUAN**, A. (eds). *Tectonics of the Western Mediterranean and North Africa*. Geol. Soc., London, Spec. Pub., 262, 101- 118.

T.2.1_Booth-Rea, G., **Jabaloy**, A., **Azdimousa**, A., **Asebriy**, L. et al. (2012). Upper-crustal extension during oblique collision: the Temsamane extensional detachment (eastern Rif, Morocco). *Terra Nova* **24**, 505-512.

T.2.1_Booth-Rea, G., Ranero, C. R., Martínez-Martínez, J. M. & Grevemeyer, I. (2007). Crustal types and Tertiary tectonic evolution of the Alborán sea, western Mediterranean. *Geochemistry Geophysics Geosystems* **8**.

T.2.1_Benmakhlouf, M., **Galindo-Zaldivar**, J., **Chalouan**, A**., Galdeano**, C. S. et al. (2012). Inversion of transfer faults: The Jebha-Chrafate fault (Rif, Morocco). *J. African Earth Sciences* **73-74**, 33-43.

T.2.1_Pedrera, A., **Ruiz-Constan**, A., **Galindo-Zaldiva**r, J., **Chalouan**, A., **Galdeano**, C. S. et al. (2011). Is there an active subduction beneath the Gibraltar orogenic arc? Constraints from Pliocene to present-day stress field. *Journal of Geodynamics* **52**, 83-96.

T.2.2_Corsini, M et al. (2010). Exhumation processes during post-collisional stage in the Variscan belt revealed by detailed Ar^{40}/Ar^{39} study (Tanneron Massif, SE France). *International Journal of Earth Sciences* **99**, 327-50.

T.2.2&3_Sanchez, G., Rolland, Y., Schneider, J., **Corsini**, M., Oliot, E., Goncalves, P., **Verati**, C., **Lardeaux**, J.-M. & Marquer, D. (2011). Dating low-temperature deformation by Ar^{40}/Ar^{39} on white mica, insights from the Argentera-Mercantour Massif (SW Alps). *Lithos* **125**, 521-536.

T.2.2&1.2_Sanchez, G., Rolland, Y., **Corsini**, M., et al. (2010). Relationships between tectonics, slope instability and climate change: Cosmic ray exposure dating of active faults, landslides and glacial surfaces in the SW Alps. *Geomorphology* **117**, 1-13.

T.2.3_Lofi, J., Berne, S., Tesson, M., **Seranne**, M. & Pezard, P. (2012).Giant solution-subsidence structure in the Western Mediterranean related to deep substratum dissolution. *Terra Nova* **24**, 181-188.

T.2.3_Seranne, M. & Anka, Z. (2005). South Atlantic continental margins of Africa: A comparison of the tectonic vs climate interplay on the evolution of equatorial west Africa and SW Africa margins. *Journal of African Earth Sciences* **43**, 283-300.

T.2.3_Keller, G., Adatte, T., Berner, Z., **Chellai**, E. H. & Stueben, D. (2008). Oceanic events and biotic effects of the Cenomanian-Turonian anoxic event, Tarfaya Basin, Morocco. *Cretaceous Research* **29**, 976-994. 10.1016/j.cretres.2008.05.020.

T.2.3_Coster, P., Benammi, M., Mahboubi, M., Tabuce, R., **Adaci, M**., **Marivaux**, L., **Bensalah**, M. et al. (2012). Chronology of the Eocene continental deposits of Africa: Magnetostratigraphy and biostratigraphy of the El Kohol and Glib Zegdou Formations, Algeria. Geological Society of America Bulletin **124**, 1590-1606.

T.2.3_Vernhet, E., Youbi, N., **Chellai** et al. (2012). The Bou-Azzer glaciation: Evidence for an Ediacaran glaciation on the West African Craton (Anti-Atlas, Morocco). *Precambrian Research* **196**, 106-112.

T.2.3_Hamon, Y. & **Merzeraud**, G. (2008). Facies architecture and cyclicity in a mosaic carbonate platform: effects of fault-block tectonics (Lower Lias, Causses platform, south-east France). *Sedimentology* **55**, 155-178.

T.2.4_Lecuyer, C., Daux, V., Moissette, P., **Cornee**, J.-J. et al. (2012). Stable carbon and oxygen isotope compositions of invertebrate carbonate shells and the reconstruction of paleotemperatures and paleosalinities-A case study of the early Pleistocene of Rhodes, Greece. *Palaeog Palaeoclimatology Palaeoecology* **350**, 39-48.

T.2.4_Moissette, P., **Cornee**, J.-J.,et al. . (2010). The western edge of the Mediterranean Pelagian Platform: A Messinian mixed siliciclastic-carbonate ramp in northern Tunisia. *Palaeogeography Palaeoclimatology Palaeoecology* **285**, 85-103.

T.2.4&3_Oudet, J., **Munch**, P., **Verati**, C., Ferrandini, M., Dobrinescu, M., Gattacceca, J., **Cornee**, J. J., et al. (2010). Integrated chronostratigraphy of an intra-arc basin: Ar-40/Ar-39 datings, micropalaeontology and magnetostratigraphy of the early Miocene Castelsardo basin (northern Sardinia, Italy). *Palaeogeography Palaeoclimatology Palaeoecology* **295**, 293-306.

T.2.4&5_Amami, B., Muller, S. D., **Rhazi**, L. et al. (2010). Modern pollen-vegetation relationships within a small Mediterranean temporary pool (W Morocco). *Review of Palaeobot. & Palynology* **162**, 213-225.

T.2.5_Sabatier, P., **Dezileau** et al. (2012). 7000 years of paleostorm activity in the NW Mediterranean Sea in response to Holocene climate events. *Quaternary Research* **77**, 1-11.

T.2.5_Sabatier, P., **Dezileau**, et al. (2008). Reconstruction of paleostorm events in a coastal lagoon (Hérault, South of France). *Marine Geology* **251**, 224-232.

T.2.5&3_Melki, T., **Kallel** et al. (2009). Abrupt climate change, sea surface salinity and paleoproductivity in the western Mediterranean Sea (Gulf of Lion) during the last 28 kyr. *Palaeog Palaeoclim Palaeoecol* **279**, 96-113.

T.2.5&3_Melki, T., **Kallel** et al. (2010). The nature of transitions from dry to wet condition during sapropel events in the Eastern Mediterranean Sea. *Palaeogeog. Palaeoclimat. Palaeoecol.* **291**, 267-285.

Expertise WP2—Deep Structures and Mantle Processes (T=task)

WP1-2_**Chalouan** et al. (2008): The Rif Belt. In: *The Geology of Morocco: Structure, Stratigraphy and Tectonic of the Africa-Atlantic-Mediterranean Triple Junction*. Michard, O. Saddiqi, A. **Chalouan** et al. eds, Springer-Verlag. Berlin. Lecture Notes in Earth Sciences, 116.

T.3.1_**Ruiz-Constan**, A., **Galindo-Zaldivar**, J., **Pedrera**, A., Arzate, J. A., Pous, J., Anahnah, F., Heise, W., Monteiro Santos, F. A. & Marin-Lechado, C. (2010). Deep deformation pattern from electrical anisotropy in an arched orogen (Betic Cordillera, western Mediterranean). *Geology* **38**,

T.3.1_**Ayadi** A., C. Dorbath, A. Lesquer and M. **Bezzeghoud** (2000). Crustal and upper mantle velocity structure of the Hoggar Swell (Central Sahara, Algeria). *Phys. Earth and Plan. Int.*, 118, 111- 123.

T.3.1_**Tiberi**, C et al. (2005). Inverse models of gravity data from the Red Sea-Aden-East African rifts triple junction zone. *Geophysical Journal International* **163**, 775-787.

T.3.1_O'Donnell, J. P., Daly, E., **Tiberi** et al. (2011). Lithosphere-asthenosphere interaction beneath Ireland from joint inversion of teleseismic P-wave delay times and GRACE gravity. *Geophys. Journal Int.* **184**, 1379-1396.

T.3.1_ Anahnah, F., **Galindo-Zaldivar**, J., **Chalouan**, A., **Pedrera**, A., **Ruano**, P., Pous, J., Heise, W., **Ruiz-Constan**, A., **Benmakhlouf** et al. (2011). Deep resistivity cross section of the intraplate Atlas Mountains (NW Africa): New evidence of anomalous mantle and related Quaternary volcanism. *Tectonics* **30**.

T.3.2_**Bodinier**, J. L. & Godard, M. (2006). Orogenic, Ophiolitic and Abyssal Peridotites. In: Carlson, R. W. (ed.) *Treatise on Geochemistry. 2. Geochemistry of the Mantle and Core*: Elsevier.

T.3.2&4 **Bruguier**, O., **Hammor**, D., **Bosch**, D. & Caby, R. (2009). Miocene incorporation of peridotite into the Hercynian basement of the Maghrebides (Edough massif, NE Algeria): Implications for the geodynamic evolution of the Western Mediterranean. *Chemical Geology* **261**, 172-184.

T.3.2_ Vauchez, A., **Tommasi**, A. & Mainprice (2012). Faults (shear zones) in the Earth's mantle. *Tectonophysics* **558-559**, 1-27.

T.3.2&4 **Garrido**, C. J., Gueydan, F., **Booth-Rea**, G. et al. (2011). Garnet-spinel mylonite in the Ronda peridotite: Vestiges of Oligocene backarc mantle lithospheric extension in the western Mediterranean. *Geology* **39**, 927-930.

T.3.2_ Marchesi, C., **Garrido**, C. J., **Bosch**, D., **Bodinier** et al. (2013). Mantle refertilization by melts of crustal-derived garnet pyroxenite: Evidence from the Ronda peridotite. *Earth and Planet. Science Letters* **362**, 66-75.

T.3.2&4 Hidas, K**., Booth-Rea**, G., **Garrido**, C. J., et al. (2013). Backarc basin inversion and subcontinental mantle emplacement in the crust: kilometre-scale folding and shearing at the base of the proto-Alborán lithospheric mantle (Betic Cordillera, southern Spain). *Journal of the Geological Society* **170**, 47-55.

T.3.2_ Frets, E., **Tommasi**, A., **Garrido**, C. J, Padrón, J. A., **Amri**, I. & **Targuisti** (2012). Deformation processes and rheology of pyroxenites under lithospheric mantle conditions. *Journal of Structural Geology* **39**, 138-157.

T.3.2_**Alard**, O., Lorand, J.-P., Reisberg, L., **Bodinier**, J.-L., et al. (2011). Volatile-rich metasomatism in Montferrier Xenoliths (Southern France): Implications for the abundances of chalcophile and highly siderophile elements in the Subcontinental Mantle. *Journal of Petrology* **52**.

T.3.3_ **Ouali *et al***. (2003) Le volcanisme du Maroc central: implications géodynamiques. *C. R. Géosc 33.*

T.3.3_ Almeev, R. R., Holtz, F., Koepke, J. & **Parat, F. (2012).** Experimental calibration of the effect of H_2O on plagioclase crystallization in basaltic melt at 200 MPa. *American Mineral.* 97, 1234-1240.

T.3.3_ **Parat** *et al.* (2011). S-rich apatite-hosted glass inclusions in xenoliths from La Palma: constraints on the volatile partitioning in evolved alkaline magmas. *Cont. to Mineral. and Petrology* 162, 463-478.

T.3.3_ Marchesi, C., **Garrido**, C. J., **Bosch** et al. (2007). Geochemistry of Cretaceous Magmatism in Eastern Cuba: Recycling of North American Continental Sediments and Implications for Subduction Polarity in the Greater Antilles Paleo-arc. *Journal of Petrology* **48**, 1813-1840.

T.3.3_**Azzouni**, A., Bonin, B., **Benhallou**, A., **Yahiaoui**, R. & Liegeois, J.-P. (2007). Cenozoic alkaline volcanism of the Atakor massif, Hoggar, Algeria. In: Beccaluva, L., Bianchini, G. & Wilson, M. (eds.) *Cenozoic Volcanism in the Mediterranean Area*, 321-340.

T.3.3_ Beccaluva, L., **Azzouni**, A., **Benhallou**, A., et al.. (2007). Intracratonic asthenosphere upwelling and lithosphere rejuvenation beneath the Hoggar swell (Algeria): Evidence from HIMU metasomatised lherzolite mantle xenoliths. *Earth and Planetary Science Letters* **260**,

T.3.3_ Coulon, C., Megartsi, M., Fourcade, S., Maury, R. C., Bellon, H., **Louni** et a. (2002). Post-collisional transition from calc-alkaline to alkaline volcanism during the Neogene in Oranie (Algeria): magmatic expression of a slab breakoff. *Lithos* **62**, 87-110.

T.3.4_ Bosch, D., **Hammor**, D., **Bruguier**(2002). Monazite 'in situ' $^{207}Pb/^{206}Pb$ geochronology using a small geometry High-Resolution Ion Probe. Application to Archean and Proterozoic rocks. *Chemical Geology* **184**, 151-165.

T.3.4_Caby, R., **Hammor, D**. & Delor, C. (2001). Metamorphic evolution, partial melting and Miocene exhumation of lower crust in the Edough metamorphic core complex, west Mediterranean orogen, eastern Algeria. *Tectonophysics* **342**, 239-273. 10.

T.3.4_ Hammor, D., **Bosch**, D., Caby, R. & **Bruguier**, O. (2006). A two-stage exhumation of the Variscan crust: U-Pb LA-ICP-MS and Rb-Sr ages from Greater Kabylia, Maghrebides. *Terra Nova* **18**, 299-307.

T.3.4&2.1_ Aerden, D. Sayab, M. & Bouybaouene- **Belhassan**, M. L. (2010). Conjugate-shear folding: A model for the relationships between foliations, folds and shear zones. *Journal of Structural Geology* **32**, 1030-1045.

T.3.4&12.1_ Negro, F., Beyssac, O., Goffe, B., Saddiqi, O. & Bouybaouene-**Belhassan**, M. L. (2006). Thermal structure of the Alboran Domain in the Rif (northern Morocco) and the Western Betics (southern Spain). Constraints from Raman spectroscopy of carbonaceous material. *Journal of Metamorphic Geology* **24**, 309-327.

T.3.4&12.1_ Rossetti, F., Theye, T., Lucci, F., Bouybaouene-**Belhassan**, M. L., (2010). Timing and modes of granite magmatism in the core of the Alboran Domain, Rif chain, northern Morocco: Implications for the Alpine evolution of the western Mediterranean. *Tectonics* **29**.

Expertise WP4—Applied Geology (T=task)

WP4 _Michard, O. Saddiqi, **A. Chalouan**, et al. (Eds). (2011): *New geological and mining guidebooks of Morocco*. Notes et Mémoires du Service géologique du Maroc. **9 volumes** (556 -564).

T.4.2_for more expertise on this task, refer to publications in **WP3-task 2.3** ("Basin Analysis").

T.4.2_Klein, F. & **Garrido**, C. J. (2011). Thermodynamic constraints on mineral carbonation of serpentinized peridotite. *Lithos* **126**, 147-160.

T.4.3_Fakhfakh, E., Hajjaji, W., Medhioub, M., Rocha, F., **Lopez-Galindo**, A., **Setti**, M., Kooli, F., Zargouni, F. & **Jamoussi**, F. (2007). Effects of sand addition on production of lightweight aggregates from Tunisian smectite-rich clayey rocks. *Applied Clay Science* **35**, 228-237. 10.1016/j.clay.2006.09.006.

T.4.3_Jeridi, K., Hachani, M., Hajjaji, W., Moussi, B., Medhioub, M., **Lopez-Galindo**, A., Kooli, F., Zargouni, F., Labrincha, J. & **Jamoussi**, F. (2008). Technological behaviour of some Tunisian clays prepared by dry ceramic processing. *Clay Minerals* **43**, 339-350. 10.1180/claymin.2008.043.3.01.

T.4.3_Lopez-Galindo, A., Viseras, C. & Cerezo, P. (2007). Compositional, technical and safety specifications of clays to be used as pharmaceutical and cosmetic products. *Applied Clay Science* **36**, 51-63. 10.1016/j.clay.2006.06.016.

T.4.3_Lopez-Galindo, A., Viseras, C., Aguzzi, C. & Cerezo, P. (2011). Pharmaceutical and Cosmetic Uses of Fibrous Clays. In: Galan, E. & Singer, A. (eds.) *Developments on Nanomaterials*, 299-324.

1.3.2 Experience of the partners in international cooperation

All the researchers involved MEDYNA has a long-track record of international cooperation with first-class Earth Sciences research institutes worldwide, and many are involved in leading international Earth Science initiatives in NW Africa (*qv.* Sec. 1.1.3). One of the **major assets of MEDYNA is relying on a well-established trans-Mediterranean cooperation network involving a large number of participants from several Maghreb universities and research institutes working in complementary Earth Science research fields**. Since more than two decades, there have been EU-Maghreb exchanges of researcher between MEDYNA partners, mostly by means of bilateral projects funded by national agencies. The cooperation network NALMIN (North African Lithosphere and Mantle Imaging Network) involves UM2, IACT-CSIC and research institutes from Algiers, Annaba, Meknes, Rabat, and Tlemcen. The NALMIN network is actively supported by CNRS (DRI and INSU) and Hubert-Curie-Parnetships (PHC) projects coordinated by JL Bodinier at UM2 (Picasso, Volubilis, Tassili and Imhotep PHC). Many MAEC-AECID (Spain) international cooperation projects in themes related to WPs 1-4 exit between CSIC-UGR and Maghreb institution from Tetouan, Oujda, Rabat and Tunisia. The Volubilis PHC (2010-2013-Granada, Meknes, Montpellier and Tetouan) and the Meknes-Montpellier CNRS-CNRST agreements are closely related to WP3 and provide support to four co-advised PhD theses for Moroccan students involved MEDYNA. The WP1 is related to several Agence Universitaire de la Francophonie (AFU) network (Rigo, UPS, Tolouse) involving the UAE-Tetouan, CNRST-Rabat (Morocco), Tunisian universities, ENS-Paris (France), and UEVORA-CGE (Portugal). The UEVORA-CGE participates in the North African Group for Earthquake and Tsunami studies (NAGET) involving several MEDYNA participants in WP1. WP2 and WP3 and are also associated with a wide cooperation network involving Marrakech, Oujda, Tetouan, Montpellier, Nice and Granada. MEDYNA beneficiaries and Maghreb partners are equally involved in the scholarship schemes for exchange and cooperation between Europe and the Maghreb Erasmus Mundus Averroes and Eramus Mudus Al Idrisi, leaded by MEDYNA institutions. **These are just a few of the over 50 collaborative international projects where MEDYNA researchers lead and/or participate**.

1.4 Complementarities and synergies between the partners

As can be seen in Table 6**, complementarity and cross- and trans-disciplinarity**—as a mean to catalyze and maximize synergies among fragmented research fields—**is at the very heart of the design of the MEDYNA research staff exchange scheme**. At least three MEDYNA partners are currently conducting research projects that overlap and complement each other in ways that would bring specific benefits to all parties. The aforementioned list of publications demonstrates how some of these complementarities have already been exploited delivering research of excellence and high international visibility. There are many potential synergy and collaborative research between groups that work in the same geographical area and discipline, but that have not yet join forces due to the lack

of a proper exchange framework for collaboration. There is also an urgent need for cross-disciplinary research and feedback between specialists working in seismic, mantle petrology, volcanism, tectonics, and georesources; likewise, there are potential synergies in trans-disciplinary research involving paleo-climate and extreme climate events with disciplines in WP1-3 dealing with deep dynamic processes. **The focus-site, integrated Earth Sciences approach of MEDYNA will make possible to explore and exploit these synergies and complementarities and proactively disseminate the results of the project, guaranteeing its endurance beyond the ILP-CC project**.

2 TRANSFER OF KNOWLEDGE (ToK)

2.1 Quality and mutual benefit of the transfer of knowledge

2.1.1 Programme for the transfer of knowledge between the partners

In order to ensure an effective and sustainable transfer of knowledge (ToK) between participant institutions, MEDYNA has a **dedicated Work Package on "Transfer of Knowledge, Dissemination and Outreach (WP5)"**. This WP will manage a tightly structured ToK exchange programme encompassing an **(i) online dissemination, training and discussion platform, as well as ToK driven by (ii) collaborative research, (iii) onsite training, workshops and meetings, (iv) joint scholarly publications, and (v) other dissemination and outreach activities**. This comprehensive ToK scheme will exploit the plethora of trans/multidisciplinar expertise of MEDYNA researchers as an asset to create a productive synergistic and sustainable transfer of knowledge that will allow developing a shared agenda for future research and a conceptual and methodological framework for new joint research ventures between EU and Maghreb researchers.

2.1.1.1 Online dissemination, training and discussion platform

We will set up a dedicated MEDYNA website with a permanent address for the dissemination of activities and the ToK between the consortium partners and other interested parties. The MEDYNA web site will also be online training platform where we compile selected conferences and courses—held at the premises of participants or elsewhere and always respecting strictly IPRs and confidentiality—from which all MEDYNA participants and the interested community will greatly benefit. It will also include a discussion forum built around the MEDYNA research-focus WPs in order to spark synergies and obtain feedback. This online platform will be used to distribute internal documents, access to institutional repositories of open access material and to other deliverables (outreach material, press release, etc.) generated by MEDYNA researchers. The online system will be fully accessible in some parts and restrained via login in others more useful or confidential to the MEDYNA researchers. To be an effective tool of ToK and dissemination, the website will be maintain and updated weekly by the CSIC-IACT IT staff under the supervision of the MEDYNA assistant coordinator and in close collaboration with responsible scientists of WP5 and, whenever necessary, with the involvement of all the MEDYNA community.

2.1.1.2 Collaborative Research

The core ToK activity will be mainly provided within the MEDYNA project by means of the research carried out by detached staff at the host institutions. The aim is to provide a deep exchange of information and knowledge by means of joint work on the same subject, which is an ideal way to share the knowledge gained in similar projects and the transfer of the gained experience from each partner to the other ones at the return of seconded staff at her/his institution. Whenever possible, detached staff will be working at the same time and place with other detached staff working in the same WP and other WPs. Interpersonal ToK exchange will involve interaction between at least one experienced and more junior researcher who will work closely together for an extended period under co-supervised PhDs. This ToK is designed to build high quality research capacity for MPC and beneficiary researchers, as well as to share knowledge among different levels of research experience and expertise.

2.1.1.3 Onsite training

Onsite training will be provided by designated, incoming seconded staff at the host institutions and will comprise one day mini-course about the tools and/or research developed by incoming staff in her/his host institution. The training will be publicized and available upon request to other researchers at the institution. Where available, onsite training mini courses will be attended by other MEDYNA participants via videoconferencing. These courses will eventually form the basis for the web site videos and training information (either the open-access or the restricted-access one) to be disseminated. On-site training of incoming staff will be also accomplished by encouraging the hosted researchers to attend short course and training sessions at the host institution and at weekly and topical seminars that run at the premises all the MEDYNA participant institutions and, if possible, will be open to MEDYNA participants via videoconferencing and or the MEDYNA website.

2.1.1.4 Programme of Workshops and Meetings

MEDYNA Workshops. The participant institutes will organize **two** topical MEDYNA workshops to provide a forum for exchange of ideas and the development of the scientific plans of each individual WP. The first MEDYNA workshop will take place within the first two year (*qv.* Milestones) of the ILP-CC to the effective creation of a network by meeting of all participants and to provide them with a common background via lectures delivered by keynote speakers from participant and third institutions. The second MEDYNA workshop will be organized by MPC participant institution(s) at the end of the project. MEDYNA workshops will be the place for the discussion of consensus White Papers for attaining a sustainable collaboration among EU-Maghreb researchers on Integrated Earth Sciences Studies, as the mean for future collaboration in joined research projects, and the engagement of political and industrials stakeholders. Thematic symposiums will be organized around the MEDYNA WPs and informal cross-disciplinary round-tables to catalyze synergistic interactions through lively discussions between participants involving researchers from different WPs. These workshops will be

open to external participation. We do not expect MEDYNA to cover the costs of these workshops, although it will facilitate the participation of MPC researchers.

Symposiums at International Conferences. Each partner will propose sessions at national and leading international research conferences (e.g. EGU and AGU) to disseminate and build on the knowledge generated by this programme. We plan at least 2 sessions in alternate years to the MEDYNA workshops. These sessions will encourage the participation of experts beyond MEDYNA. MEDYNA researchers have organized already topical and network-wide MEDYNA sessions yearly at the EGU meeting Vienna and the AGU Fall Meeting in San Francisco (USA). These initiatives will continue and grow with MEDYNA.

2.1.1.5 Joint publications

Joint publication in scholarly journals is one of the most effective means of ToK in science. Each WP will result in at least one scientific paper yearly. MEDYNA will encourage the circulation of paper drafts for comments among the interested MEDYNA community, so as to ensure this knowledge is shared among the participants and to tap into the trans/multidisciplinar expertise of MEDYNA researchers. Published papers will be disseminated through the website and, as far as possible, will endorse the Open Source publication policies of ERA. At the end of the project, we envisage the publication of and edited MEDYNA volume in a leading Earth Science journal (such as Tectonophysics) that will collect the results of MEDYNA and provide key reviews of research-focus WPs for their broader dissemination to the research community.

2.1.1.6 Broader-Audience Communication, Dissemination and Outreach Activities

MEDYNA will also have a dissemination programme that will target a broader audience in order to receive feedback and influence the attitudes of local, regional, national and EU decision and policy makers ensuring that the project outcomes will be taken into production. The MEDYNA Assistant Coordinator (*qv.* Sec B 3.2.1.) will be in charge of manage this task in close collaboration with the MEDYNA Coordinator and members of the SB, and the representatives of each WPs, and always ensuring the involvement of consortium partner scientists. The Assistant Coordinator will identify significant MEDYNA results and events and, depending on its relevance, publicize them through press release and other means to the local, regional and national media, as well as to the participating institutions and the European Commission. This will be done in close collaboration with professional communicators from the staff of the CSIC-UGR Communication Office, which will assist with the drafting of press releases and other communication tasks. These communications will also be publicized in the MEDYNA and institutional website. The Assistant Coordinator will invite decision and policy makers, as well as representatives of industrial stakeholders, to MEDYNA events and activities in order to increase their awareness about societal and policy issues related to Geohazards, Georesources and Environment in NW Africa. MEDYNA will also promote an outreach programme that will be based on new and available outreach activities and material for Secondary Schools—with

a particular emphasis on those at MPCs—and for dissemination to a broader audience in Open Days and Science Week events at the premises of the participant institutions.

2.1.2 Added value for the partners involved

The secondment of EU and Maghreb senior and junior scientists will contribute to the training, improvement of the scientific and education system of the institutions involved, and the strengthening of links between Maghreb and Europe scientists in the fields of Geodynamics, Geohazards and Applied Geology. MEDYNA will provide Maghreb partners with the training of a critical mass, and profit from educational, technological, industrial and cultural exchange. On the other hand, EU research staff will tap the long standing and unique know-how of Maghreb scientists on the Geodynamics, Geohazards and Applied Geology of NW Africa, and will be exposed to new ideas and unconventional approaches. This mutual benefit will reinforce existing successful collaborative networks of Mediterranean EU institutions with MPC researchers with a shared interest and vision about integrated Earth Science studies.

An additional added value of MEDYNA will be the ability to gain knowledge and research guidance in complementary disciplines to their original expertise. Details of the complementarity (and thus the expectations for the added value of gained knowledge) are referred to in Table 6.

3 IMPLEMENTATION

3.1 Capacities to achieve the objectives of the planned coordination

As demonstrated by the prior research outcome (Sec. 1.3.1), all MEDYNA participants have the complementary and necessary expertise and research infrastructures to achieve the objectives of each of the WPs. In addition MEDYNA beneficiaries and partners have the necessary provisions in their premises including modern laboratories, training facilities, technical staff and research infrastructures—including cutting-edge instrumental techniques—to accomplish the objectives of the planned cooperation.

Some of the **available research facilities/infrastructures** more relevant for MEDYNA are: **IACT** hosts high performance analytical (XRD, XRF, SEM, EBSD, CS-analyzer; Isotopic-Ratio Mass Spectrometry, micro-Raman, etc.), ultra-clean radiogenic and stable isotope labs, and state-of-the-art IT-computer, training and videoconferencing facilities. It benefits from Granada University integration/housing/training programs for foreign students, and full access to UGR's large infrastructures (Titan-HRTEM; SHRIMP-II ion probe, etc.). There is also available high-performance equipment for geophysical prospection and high-end GPS stations. It also hosts one of the best equipped Geomaterial and Clay Mineral laboratory for development of industrial applications with dedicated technical staff. The **UM2-GM & ISEM** have world-class analytical facilities in petrophysics (Paterson press, HT-HP measurement of physical properties, high-resolution electronic microscopy, EBSD with in-situ deformation capacities) and geochemistry (LA-HR-ICPMS, SIMS,

EPMA, etc.), paleobiology labs, and benefit for development of compute codes (freely distributed via UNICEF care software) to model textures and anisotropy. They also host a network of portable seismic broadband stations and GPS stations. The **CNRS-GN** hosts a high performance instruments for geochronological analyses by Ar/Ar laser probe step heating. The **UPS-IRAP** have technical staff specialized in the conception, construction, integration and operation of ground and space instruments and laboratory experiments leading to characterize physical process. For that, the laboratory has several performing instrumental platforms to meet the quality requirement of the space agencies and institutes. In addition, the **UPS-IRAP** has 3 world-class Observatory Services, which are: Seismology and Geodesy, Data processing and filing, Ground Instrumentation, and Space instrumentation. The **UEVORA-CGE** is host of the **Atmospheric Physics Observatory** (AERONET NASA network) and the **Seismological Observatory** part of the Western Mediterranean Seismological Network. It also hosts a high performance Seismological Network (24 portable broad band seismometers), Georadar, Seismic Reflection, Resistivimeter, GPS, and equipment for ND geophysical techniques (Ultrasonic velocities, ERT, Infrared Thermography and Laser Doppler Vibrometer), as well as other analytical techniques (SEM+EDS, XRF, micro-Raman, XRD, etc.). In Morocco and Algeria, there are state-of-the-art geophysical and seismic equipment, and world-class permanent seismic observatories at the **CNRST-IGN** and **CRAAG**, which are strategic national institutions commissioned to the monitoring of seismic hazards and risks. The **UM5**, **UAE**, **UMIN**, **UHC2**, **UCAM**, **UMPO**, **UABB**, **UORAN**, **USTHB**, **ENSK**, **UFAS**, **UBMA**, **USFAX**, all have modern videoconferencing, computing, meeting and training rooms, as well as IT facilities. They also host modern petrology, sedimentology, structural, paleoecology laboratories (sample preparation, microscope, etc.) with dedicated technical staff, as well as 4-wheel-drive vehicles for field work. Some of these partners, also host medium-size research infrastructures such as EDX-SEM, XRF and XRD. The **CNRSM** and **UORAN** host well-equipped laboratories (XRD, granulometry analyzer; plasticity etc.) specific for the industrial and pharmatheutical use of geomaterials.

The MEDYNA participant institutions have also **all the necessary human resources and managerial/administrative staff to execute the planned cooperation**. Researchers from MEDYNA participant institutions have an **ample experience in managing projects at the international level and management of incoming and outgoing detached ESRs and ERs worldwide**. The additional strength of MEDYNA participant institutions is that have **administrative and human resource staff and officers with long-track know-how on the specificities of the exchange of research staff between EU and Maghreb countries**. This solid expertise has been built thanks to the numerous bilateral collaborations supported by national agencies in the framework of specific incoming/outgoing exchange programmes of ERs and ESRs between EU beneficiaries and Maghreb partners (e.g., in France the programme Hubert-Curie-Parnetships-PHC, Volubilis, Tassili and Imhotep; supported by the non-profit organization Campus France; and Agence Universitaire de la Francophonie; in Spain, several programmes supported by MAEC-AECID, etc.). These agencies hold a **large network of bureaus in the participating EU and Maghreb's countries** (e.g., Campus France and AECID) with dedicated administrative and human office staff with a great and **specific**

expertise in supporting EU/Maghreb outgoing/incoming ESRs/ERs in visa, travel, legal, health and travel insurance, and housing issues that may arise during the exchange, and support them in any other administrative issues related to their research stays in the beneficiaries and/or Maghreb institutions. All participating Maghreb countries have **liaison EU-Maghreb offices** relationships at their local or parent institutions that will assist MEDYNA in issues related to the signature of the Partnership Agreement. All the Beneficiaries have **ERA-MORE Mobility Centers** and or Foundations (e.g. Kastler Foundation in France) to assist international researchers. In addition, each beneficiary and partner has a **well-staffed Research Office or International Office** that will provide practical support and help so that visitors and their families will be welcomed and quickly integrated into the host community and wider society. Due to the size of the network and space limitation of the proposal is unfeasible to describe them in detail, but further information is available at the participant institution websites provided in Table 1.

4 IMPACT

4.1 Potential to develop lasting collaboration with eligible Third Country Partners

MEDYNA scheme will be open to the interested research community for long lasting research collaboration on Integrated Earth Sciences in NW African and neighboring areas. A proof of this open and synergistic philosophy is that the present proposal has emerged and grew from a small, seed initiative (Coordination Committee MEDYNA) funded by the International Lithospheric Project in 2005 (*qv.* Sec. 1.1.3). On the other hand, the multidisciplinary and collaborative nature of MEDYNA is inherently long-term. By enabling the research exchanges foreseen in MEDYNA, **the project will reinforce on-going collaborations among European and Maghreb partners** with outstanding expertise in the areas covered by the proposal, focusing them on topics which are of common interest and that will attract further international research community. Proofs of our commitment for long lasting collaboration with Maghreb partners are the many previous bi- and trilateral projects where MEDYNA has been or are involved in the last decade (*qv.* Sec. 1.3.2). This track record of collaboration demonstrates that MEDYNA research community is committed to significantly grow by involving new partners in a synergistic action focused on Integrated Earth Sciences studies. Using the Transfer of Knowledge tools forged in this project (*qv.* Sec. 2.2.1), the **MEDYNA will lay the foundations for lasting cooperation among participants and new institutions in Europe, North Africa, and other third countries with a common interest in MEDYNA research**. Finally, it is expected that the present project will allow **establishing new competencies and unforeseen connections among participants that will allow obtaining** further funds at the national and HORIZON 2020 programmes allowing further collaboration among MEDYNA scientists.