

Royaume du Maroc

Ministère de l'Energie, des Mines, de l'Eau et de l'Environnement
Département de l'Energie et des Mines



المملكة المغربية

وزارة الطاقة والمعادن والماء والبيئة
قطاع الطاقة والمعادن



Direction of Geology



Moroccan Geology as key of the development

By M. Ahmed BENLAHKDIM
Director of Geology

OUTLINE

I

Morocco: An Emerging Country and an Attractive for investors

II

Morocco: a country with attractive geology and a long mining tradition

II-1

attractive geology

II-2

long mining tradition

III

National Roadmap for the Development of the Geological Infrastructures and Geothematic for the period of 2015 - 2025

OUTLINE

I

Morocco: An Emerging Country and an Attractive for investors

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Morocco: a country with attractive geology and a long mining tradition

II-1

attractive geology

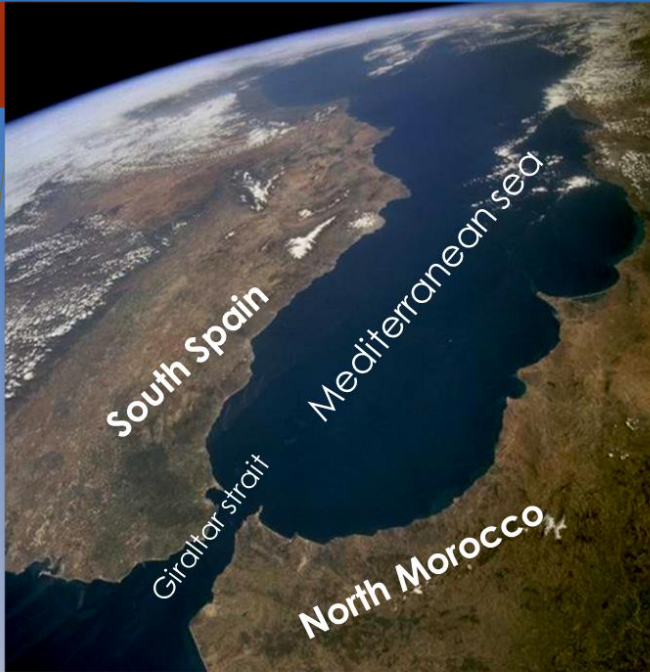
II-2

long mining tradition

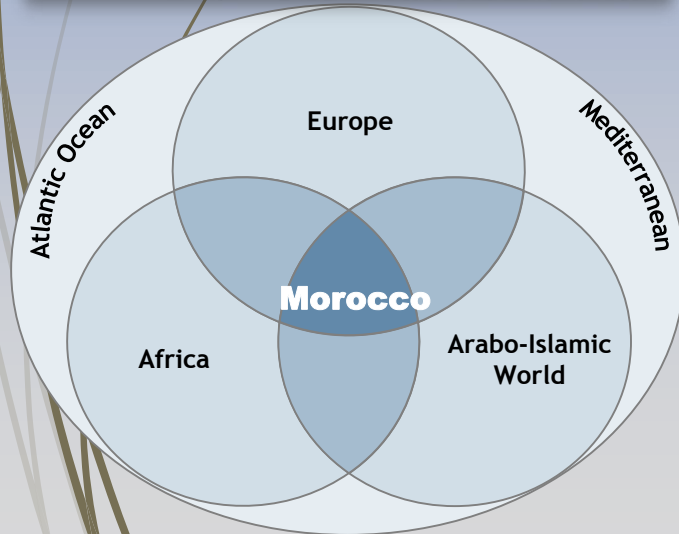
III

National Roadmap for the Development of the Geological Infrastructures and Geothematic for the period of 2015 - 2025

MOROCCO: CROSS ROAD OF CIVILISATIONS



At 15 km from Europe, Morocco is the main entrance to North of Africa. Most of the trade goes through Morocco, and the new port TANGER-MED provides another advantage to this country.



Capital	Rabat
Institutional System	Democratic and social Constitutional Monarchy
Area	710 850 km ²
N° of inhabitants	32.5 million
Time Zone	GMT (GMT+1 in summer)
Languages	Arabic and Amazigh (official) French, Spanish, English

MOROCCO: A FAVORABLE INSTITUTIONAL FRAMEWORK

- ✓ One of oldest Kingdoms in the world;
- ✓ Monarchy: high level of legitimacy, cement for the country, last recourse in terms of arbitration;
- ✓ A constitutional monarchy, constantly revisited (last revision: 1st July 2011).



Ambitious Sectoral Strategies

INDUSTRY: Performant Ecosystem Strategy 2020

Launched in 2014



- Industrial GDP to reach 23% of global GDP
- Creation of 500 000 jobs
- Creation of Industrial Development Fund: \$2.5 Bn
- Allocation of 1 000 hectares of land for rent

TOURISM: 2020 VISION

Launched in 2010



- 20 million tourists in 2020
- 200 000 new beds
- Tourism GDP: from US\$6 billion in 2010 to US\$17 billion in 2020

ENERGY: MOROCCAN SOLAR PLAN 2020

Launched in 2009 (Solar) and in 2010 (Wind)



- Renewable energy >40% of national production by 2020
- Capacity: 2 000 MW of solar power + 2 000 MW of wind power

PHARMACEUTICAL PLAN 2020

Launched in 2012



- Turnover in export: US\$1.5 billion
- Direct job creation: 12 500
- Indirect job creation: 45 000

AGRICULTURE: GREEN MOROCCO PLAN 2020

Launched in 2008



- To modernise the agricultural sector
- US\$10 billion in additional GDP from agriculture
- US\$15 billion in public and private investments

LOGISTICS PLAN 2016

Launched in 2010



- To improve the country's logistical competitiveness
- To reduce logistical costs from 20% to 15% of GDP
- An integrated national network of 70 multi-flow logistical zones

IT: NUMERICAL MOROCCO

Launched in 2009



- Generalized access to broadband
- Encourage IT use by SMEs
- Development of government e-services

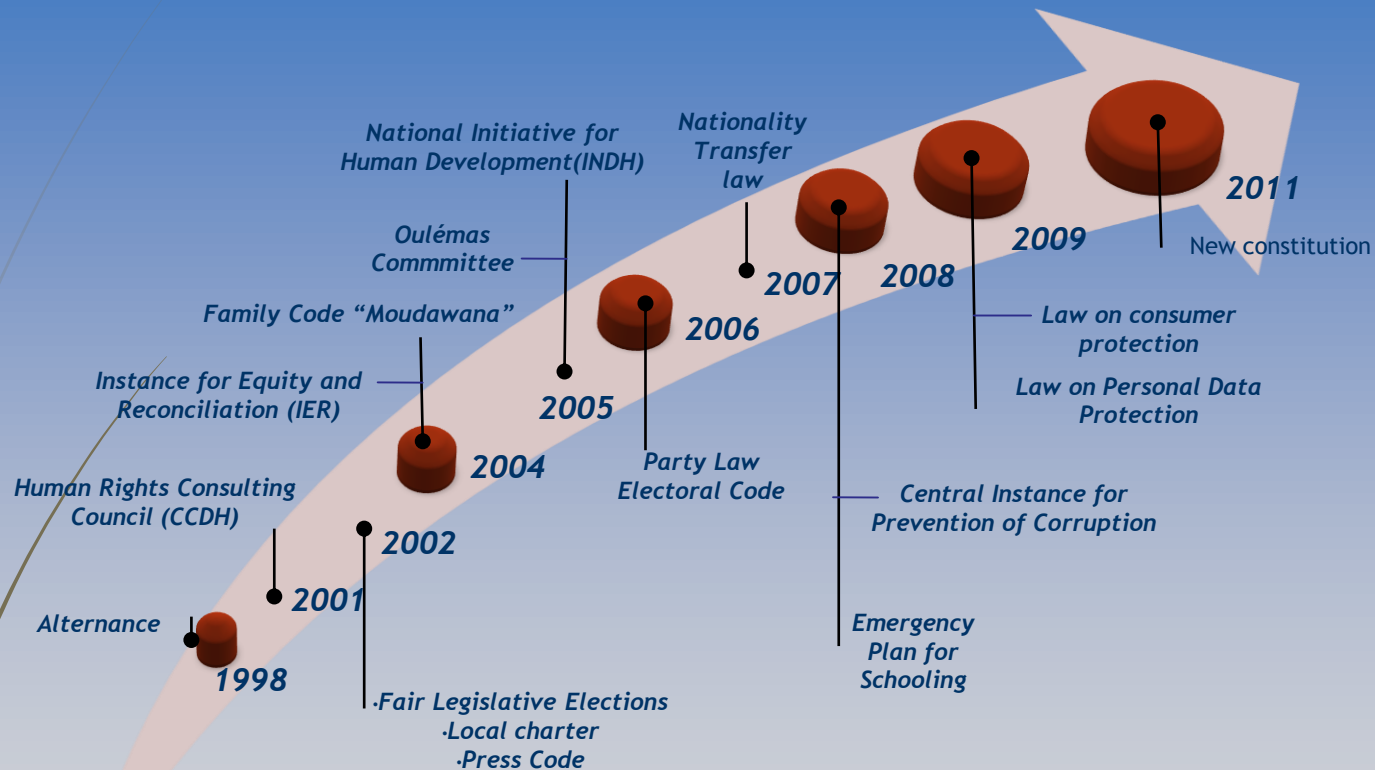
CHEMICAL PLAN 2020

Launched in 2012



- Turnover: US\$18 billion
- GDP contribution: US\$ 5.5 billion
- Job creation: 43 000

MOROCCO: ACCELERATED PROCESS OF DEMOCRATIZATION



Business Environment Favorable to Investment

Investor Protection

- **51** Double Tax Avoidance Agreements
- **62** Investment Protection Agreements
- Member of **OECD Investment Committee**
- Member of **International Centre for Settlement of Investment Disputes (ICSID)**
- Member of **MIGA** (Multilateral Investment Guarantee Agency)

Legal Reforms

- The creation of the **Business Environment National Committee (CNEA)** to facilitate procedures and access to information, and to carry out legal reforms
- The modernisation of business law
- The strengthening of intellectual property protection
- A new law on arbitration and mediation
- New banking regulations
- Administrative simplification

An Incentive Tax System

- Morocco adhered to the OECD Declaration on Propriety, Integrity and Transparency in the Conduct of International Business and Finance and to the OECD Declaration on Green Growth

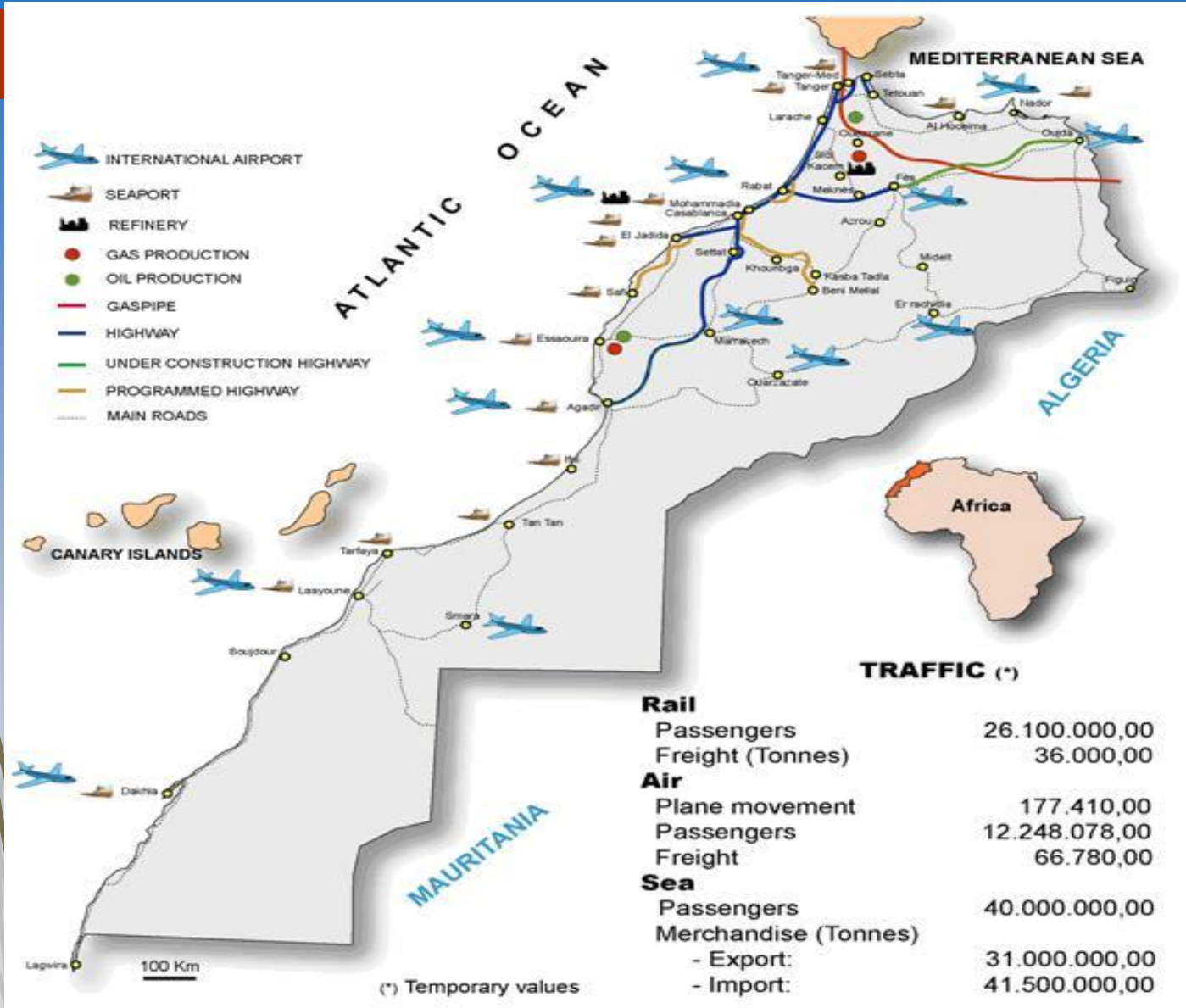
International Instruments

- Reduction of tax burden
- The creation of funds specifically for investment promotion



Morocco gained **8** positions in global ranking of "Doing Business 2014"
Morocco is "the most improved" country in business regulations in 2011
(+21 positions)

INFRASTRUCTURES



OUTLINE



Morocco: An Emerging Country and an Attractive for investors



Morocco: a country with attractive geology and a long mining tradition



attractive geology



long mining tradition



National Roadmap for the Development of the Geological Infrastructures and Geothematic for the period of 2015 - 2025

A DIVERSIFIED GEOLOGY OF MOROCCO



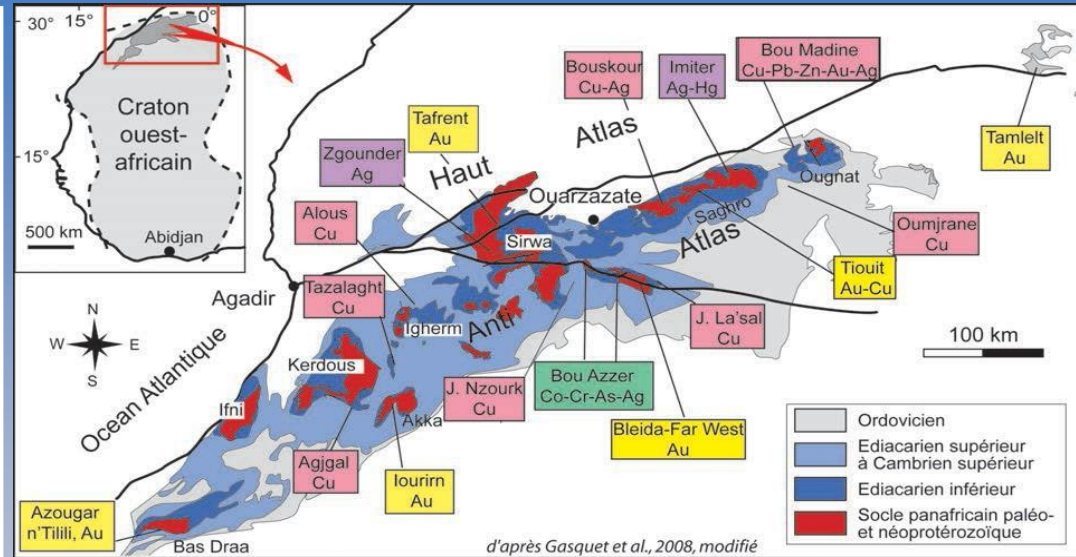
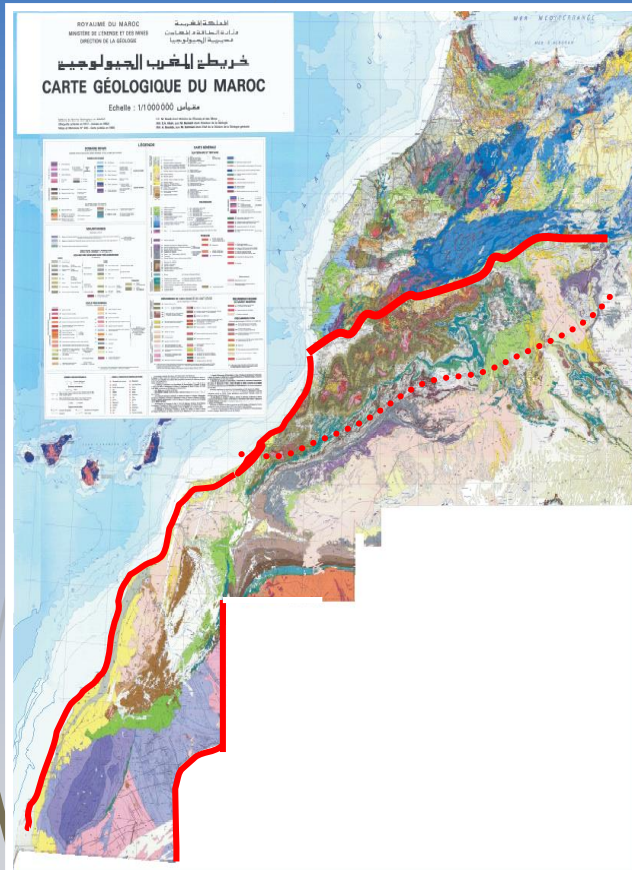
Three geological domains:

From the north to the south:

1. The Rif domain
2. The Atlas and Meseta domain
3. The Anti-Atlas and Sahara domain

The Anti-Atlas

Dominated by Precambrian and Paleozoic formations



OROGENY	MINERALIZATIONS
PANAFRICAN	<p>Cu: Kupferschiefer (Anti-Atlas), Volcanogenic (Saghro), VMS (Bleida)</p> <p>Au: Veins (Tiouit), Green Stones Belt (Bouazzer_Tafrent)</p> <p>Ag: Veins (Imiter)</p> <p>Co-Ni: veins Bouazzer</p>
EBURNEAN	<p>Au: Shear Zones (Anti-Atlas)</p>
ARCHEAN	<p>Au: Veins</p> <p>REE, Nb-Ta: with Carbonatites</p>

The Sahara domain



Migmatite of the Aghaylas suite



Granite of the Aghaylas suite and an intrusive Syenite at Awserd



Neoproterozoic unit overlying the Ma'talla suite



Intrusive Syenite in the Aghaylas suite at Awserd



Banded ironstones of the Ma'talla Group



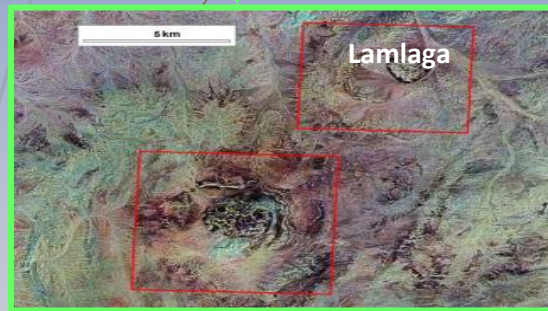
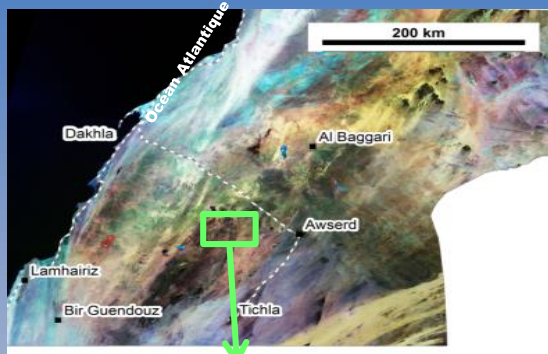
Basic Intrusives in the Ma'talla Group

Dominated by Archean in the South-East;

- **Covered by Paleozoic in the North and;**
- **Cenozoic in the West.**

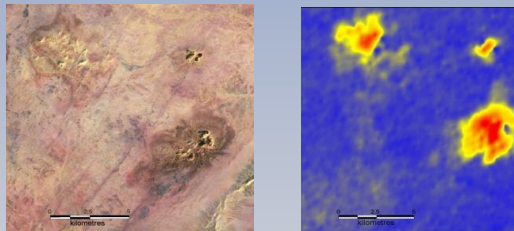
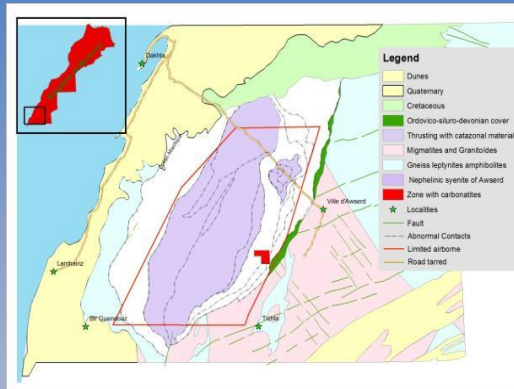
The Sahara area :Main projects in Promotion

Twhinate-Lamlaga (Nb, REE, Mo, U, Fe)

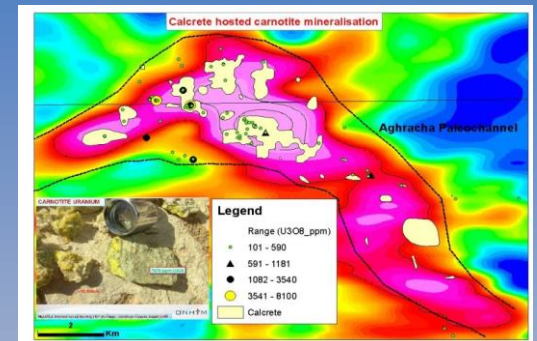


Annular structure of Twhinate & Lamlaga composed of vuggy silica breccia, iron oxides and carbonatite

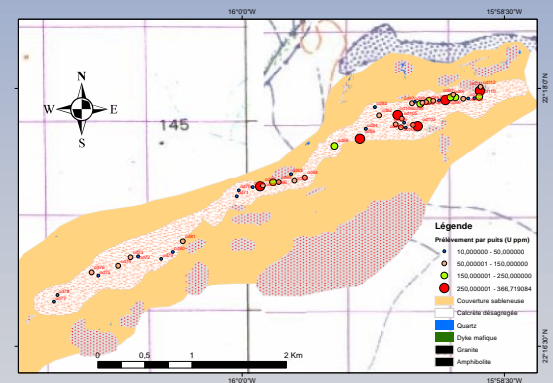
Glibat Lafhouda- Drag al Farnan (Nb, REE, Ta, U, Fe)



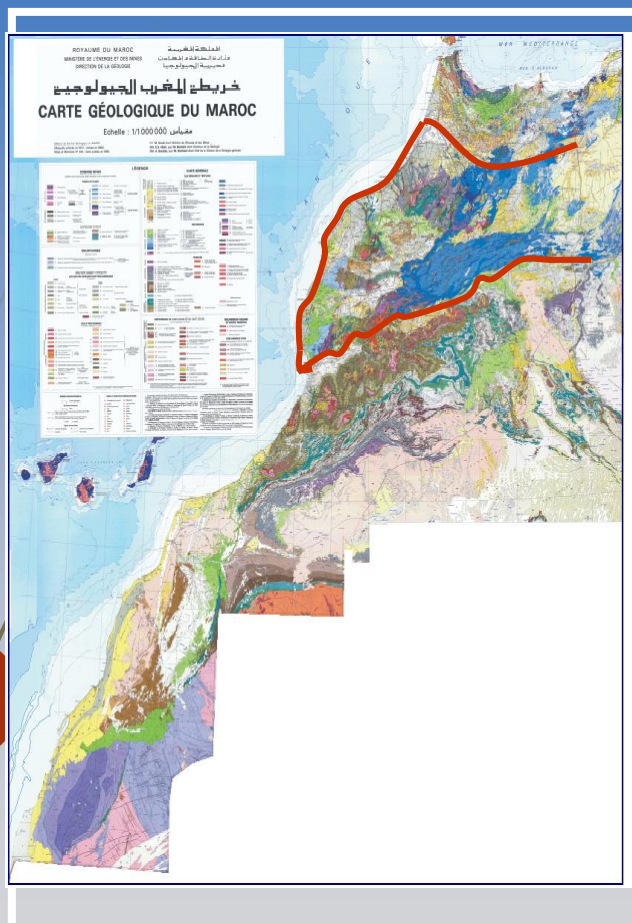
Aghracha (U, REE)



Taguendest (U)



The Atlas and Meseta domain



Triassic sediments in the central High Atlas



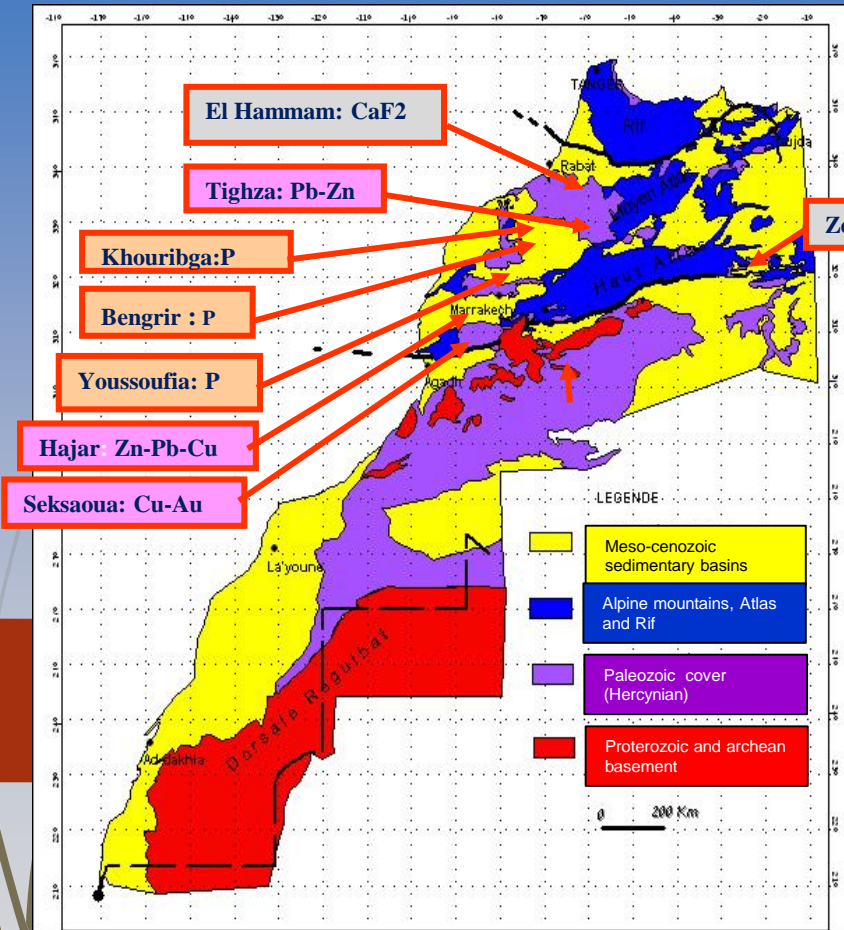
Rekkam Jurassic limestone



Mesozoic and Cenozoic cover sequence

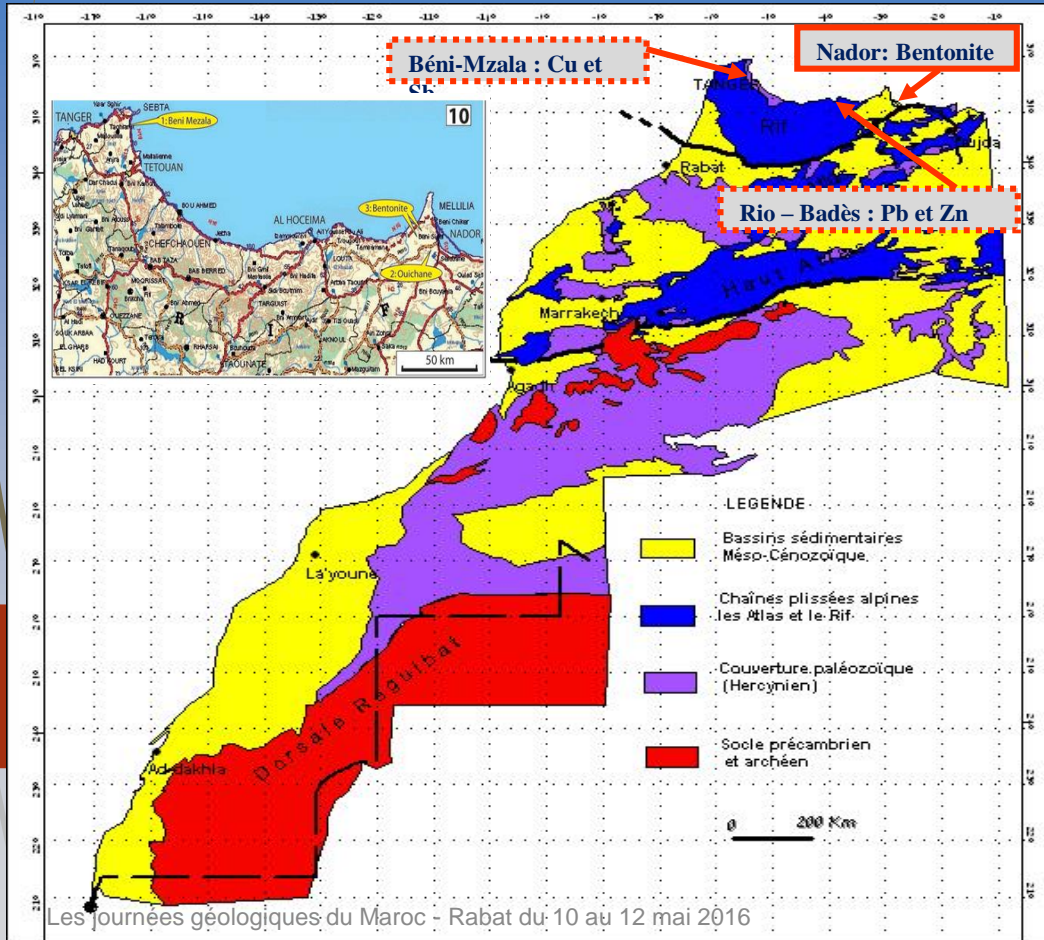
▪ Meseta	epi-Variscan platforme , Mesozoic and Cenozoic cover (phosphate mines);
▪ Atlas mountain ranges	Paleozoic basement and Mesozoic - Cenozoic carbonate sedimentary rocks.

The Atlas and Meseta domain



OROGENY	MINERALIZATIONS
<ul style="list-style-type: none"> HERCYNIAN 	<p>VMS: Pb-Zn (Jebilet-Guemmassa), Mn (Taourirt)</p> <p>Veins: Pb-Zn (Aouam, Aouli, Tafilalet), Ba (Ighoud, Zelmou, Tafilalet), Au (Bouarfa)</p> <p>Pyrometasmatic: Sn-W (Achemach, Oulmès), Mo (Azegour)</p> <p>Sedimentary: Coal (Jerrada)</p>

The Rif Domain



- Alpine mountain ranges
- Palaeozoic formations;
 - and Meso-Cenozoic rocks



Paleozoic schist in the northern Rif



Beni Bousera Peridotites

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attractive geology

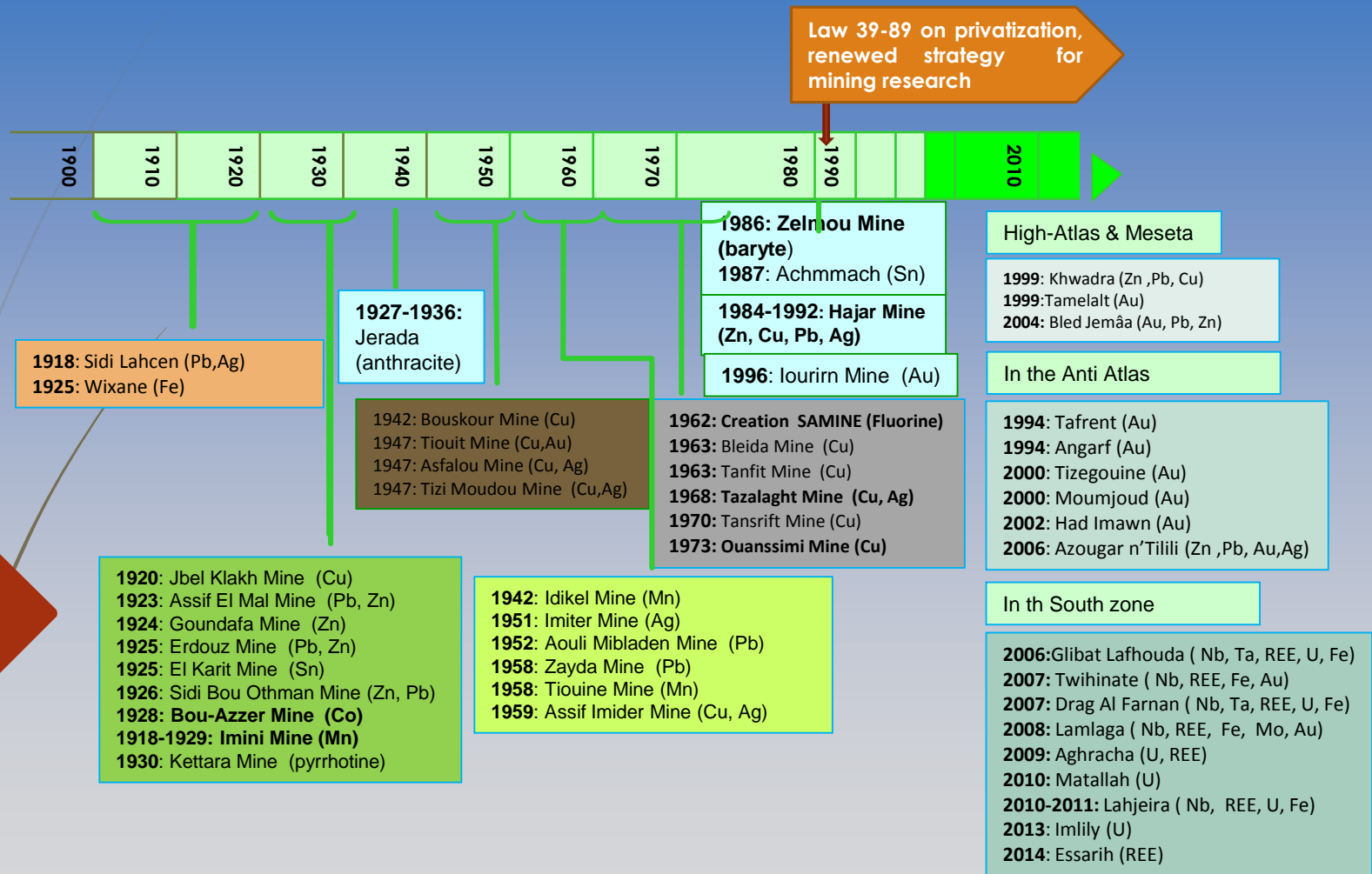


long mining tradition



National Roadmap for the Development of the Geological Infrastructures and Geothematic for the period of 2015 - 2025

A LONG MINING TRADITION



REVIEW OF MINING SECTOR

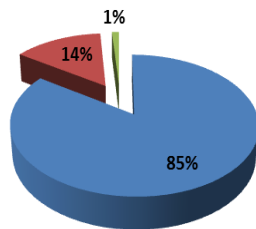
- National soil contain a wide range of minerals: phosphates, base metals, precious metals and industrial rocks and minerals;
- But the national mining industry is characterized by the predominance of phosphates (more than 90% of domestic mine production)

Main indicators - 2013

Mining Production	28,8 MT (26,4 MT phosphates)
Turnover	52 Dh Billions
Investissements	22,9 Dh Billions
Employments	40.175
Licences	6721 (at 21/11/2014)

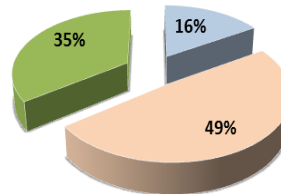
Distribution of mining permits

Par catégorie



■ Permis de recherche ■ Permis d'exploitation ■ Concessions

Par Opérateur



■ ONHYM ■ Sociétés ■ Particuliers

Substance	Production (KT)	Rank (in Africa)
Phosphates	26 400	1
Barite	094	1
Silver	0,17	1
Arsenic	9	1
Strontium	2,5	1
Lead	39	2
Zinc	91	2
Cobalt	20,3	3
Fluorite	81,2	4

Mining Sector- Vision 2025 (excluding phosphates)

	Actual.	2025
Turnover (DH Billions)	5	15
Research invest, (DH millions)	400	4.000
Employments	15.000	30.000

PHOSPHATES AND DERIVATES ... MOROCCO AS WORLD LEADER

- 1st exporter of phosphates and derivatives (150 clients across 5 continents);
- Since 2009, OCP Group conducts a commercial strategy to regulate supply and demand and mastery of prices of phosphates and derivatives;
- The objective is to increase the share of Morocco's market to 40% for all products (raw phosphate, phosphoric acid and fertilizers);
- Enhancing the position of Morocco in the African continent through increased exports of fertilizers (400,000 tons in 2013 against 50 000 tons in 2006).



PHOSPHATES AND DERIVATES ... VISION 2025

- Morocco, through the OCP SA, in its leadership position in the market for phosphates and derivatives through its development projects in the short, medium and long terms (Global Investment of US \$ 22 billion by 2025) .
- Implementation of strategic projects of the investment program focuses on:
 - Expansion of mining capacity to 50 million tons / year by 2025;
 - Strengthening logistics and transport infrastructure by commissioning in 2014 Khouribga-Jorf Lasfar pipeline (235 km),
 - Extension of the port Jorf Lasfar and Safi new phosphates' port; . Consolidation and enhancement strategy including at the chemical complex Jorf Lasfar and Safi Phosphate Hub;
 - Strengthening trade policy through the conclusion of a series of strategic partnership agreements with global players in the first place.



Extraction

4 Mines
4 Laveries



Transport

Slurry pipe line
Khouribgua-J.Lasfar



Engrais

Hub Jorf Lasfar
Hub Safi



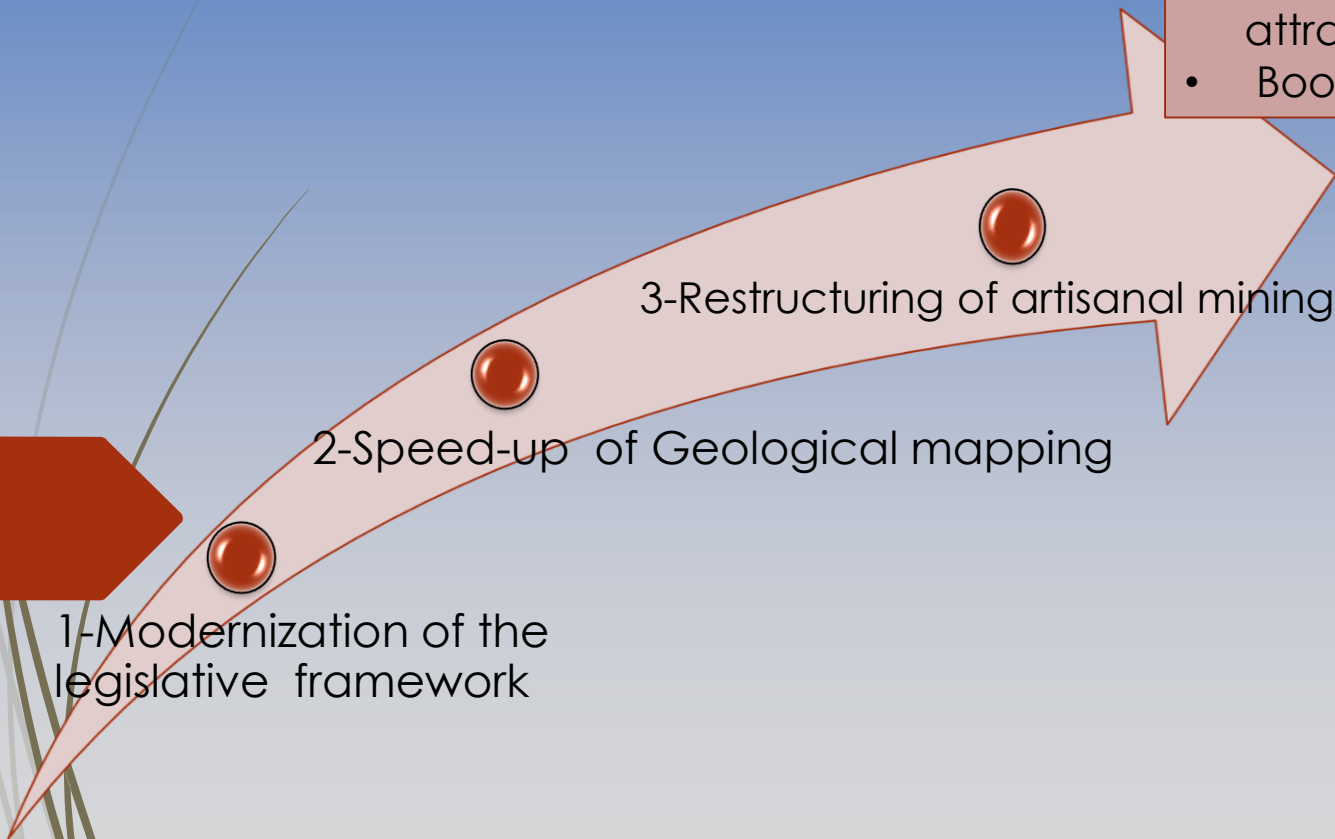
Ports Logistiques

Extension of ports
J. Lasfar and Safi

MOROCCAN MINING SECTOR PROGRESSES

Several structural projects are open to improve the attractiveness of the mining sector and the acceleration of investment mainly in the research phase:

- Make the sector attractive;
- Boost investments



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attractive geology



long mining tradition



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The National Roadmap for the Development of Geological Infrastructure and Geothematic

Recognizing the key role of geoscience mapping for infrastructure development, the Ministry of Energy, Mines, Water and Environment has included among its priorities the revitalization of the geological service in our country .

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المملكة المغربية
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والمعادن والماء
والبيئة

تقديم خارطة الطريق الوطنية لتطوير البنية التحتية الجيولوجية
والجيوموضوعاتية للفترة الممتدة من 2015 إلى 2025

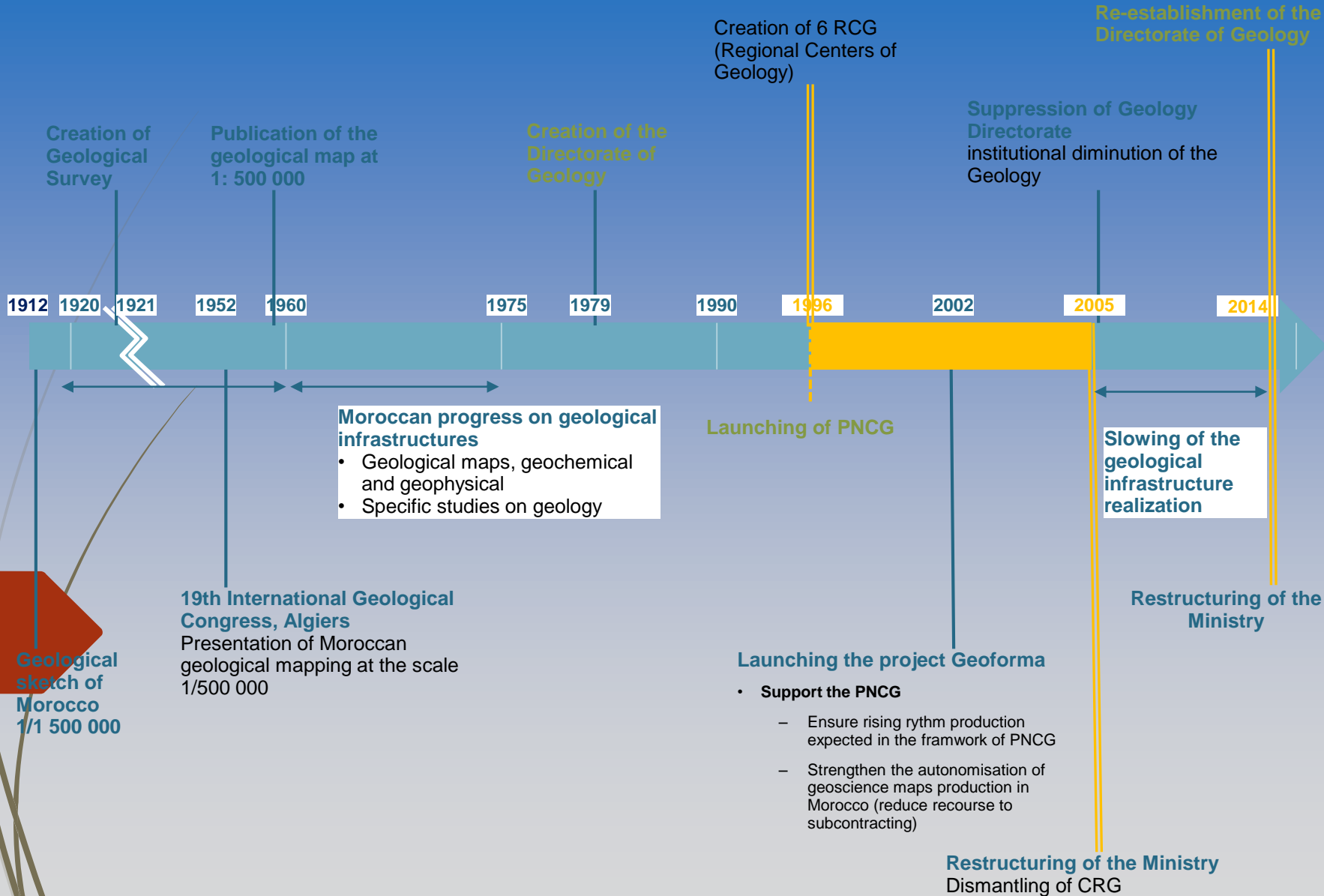
Présentation de la feuille de route nationale pour le développement
de l'infrastructure géologique et géothématique pour la période 2015 - 2025

يوم الثلاثاء 12 ماي 2015 ابتداء من الساعة التاسعة والنصف صباحا بمقر وزارة الطاقة والمعادن والماء والبيئة
Le mardi 12 mai 2015 à partir de 9h30, au siège du Ministère de l'Énergie, des Mines, de l'Eau et de l'Environnement



This national roadmap designed on the basis of a comprehensive and accurate diagnosis, was broken down into operational action plans and clear and precise objectives, taking into account the expectations and priority directions of different structural projects through the open kingdom.

Geological infrastructures: Realization's History



Diagnostic : Geological mapping faces many difficulties

1 Territory coverage

- Low rate of coverage geological, geophysical and geochemical;
- Heterogeneity of coverage rates areas with mining potential;
- thematic synthesis maps missing.

2 Quality maps

- 20% of geological maps at a non-vector format;
- No continuity of the geological boundaries between adjacent maps;
- Low rate of coverage with superimposition of geological mapping, geophysical and geochemical.

3 Rhythm of national mapping construction

- Slower rate of elaboration of the maps since 2004;
- Unplanned Geophysical maps.

4 Subcontracting

- Quality heterogeneity;
- Nuances and codes nonuniform formations;
- Delivery delays.

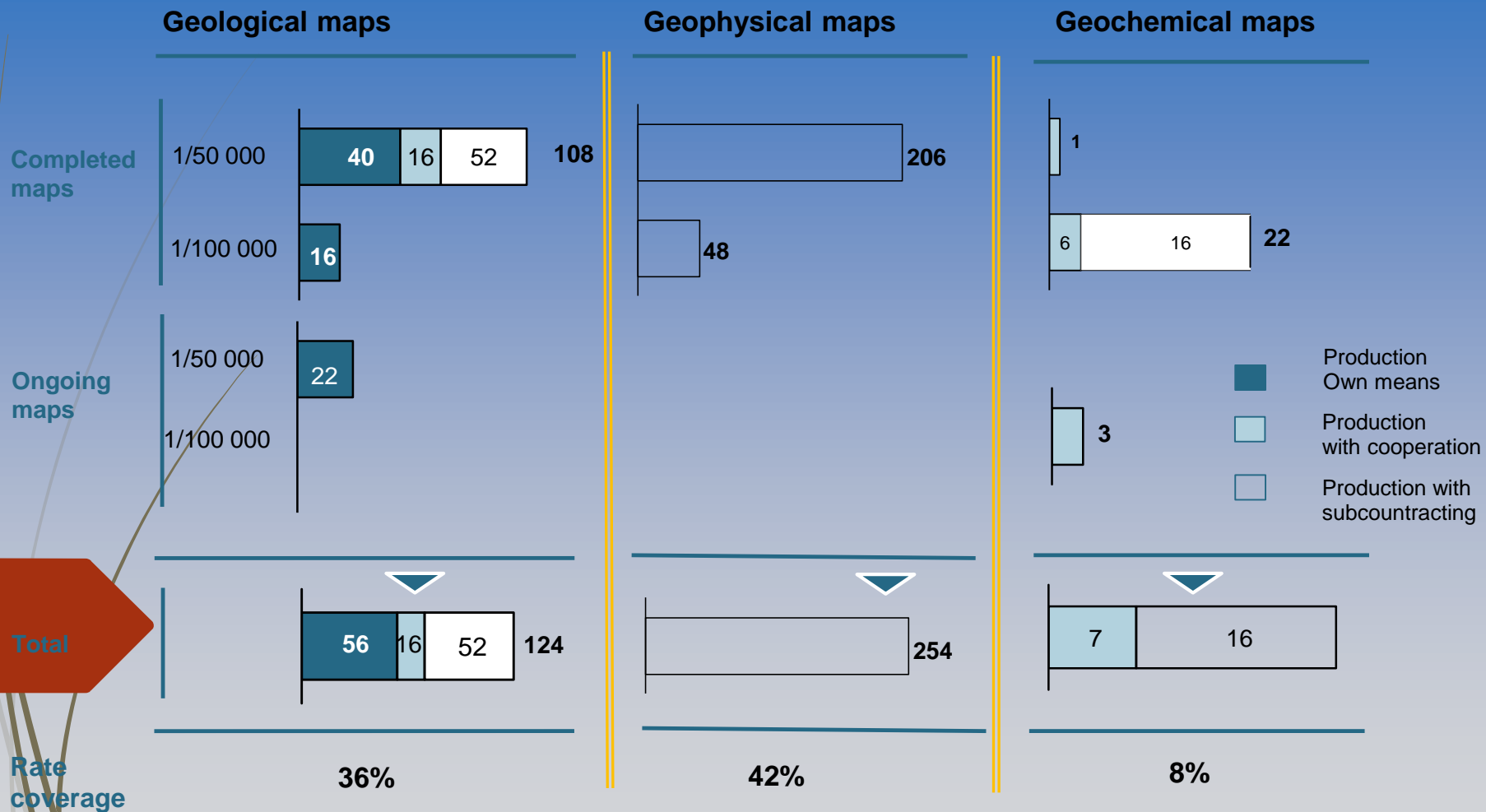
5 Means allocated to mapping

- Reducing human and budgetary means.

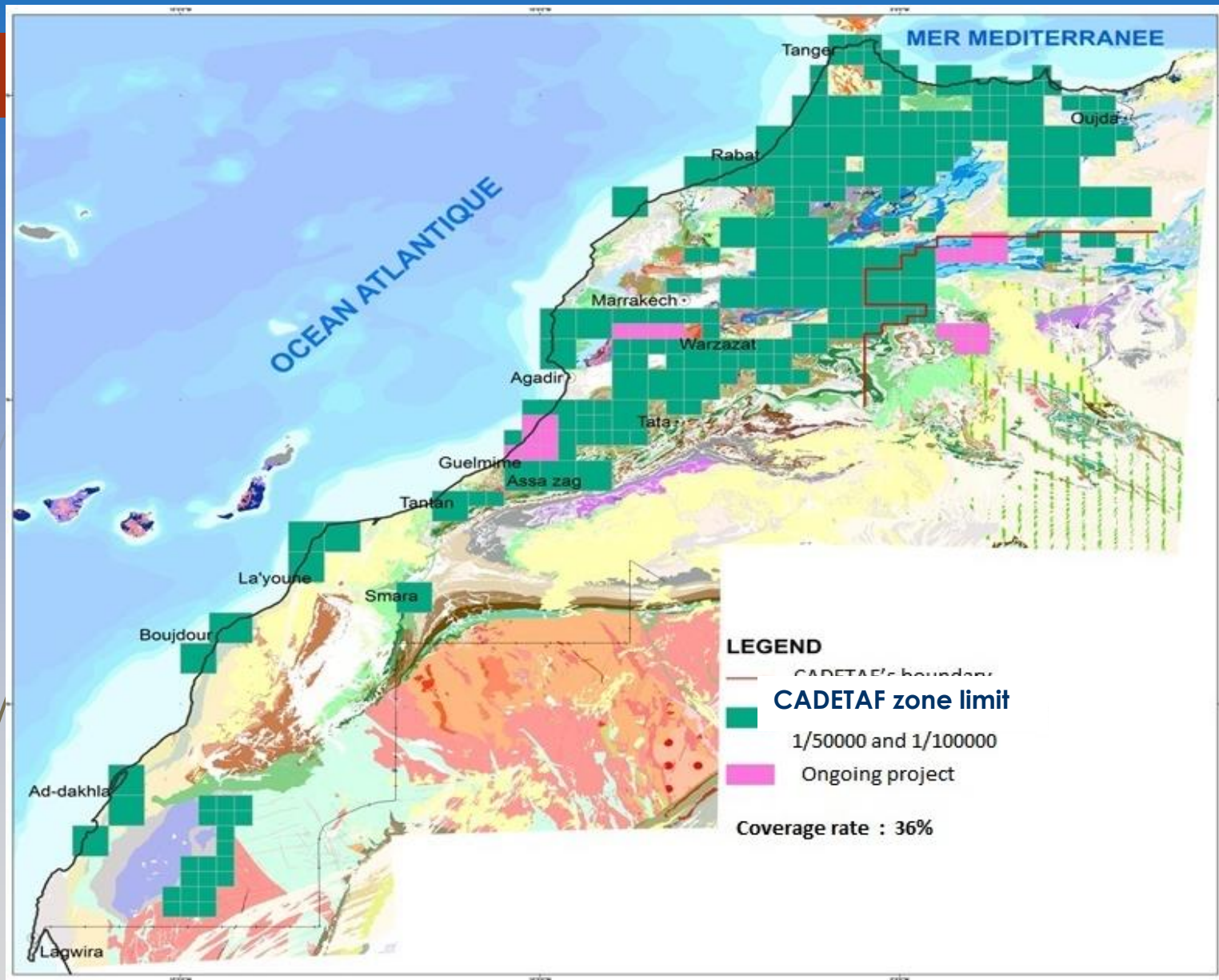
6 Infrastructures provision

- Reduced accessibility to maps;
- Absence of promotion of geoscience products to users.

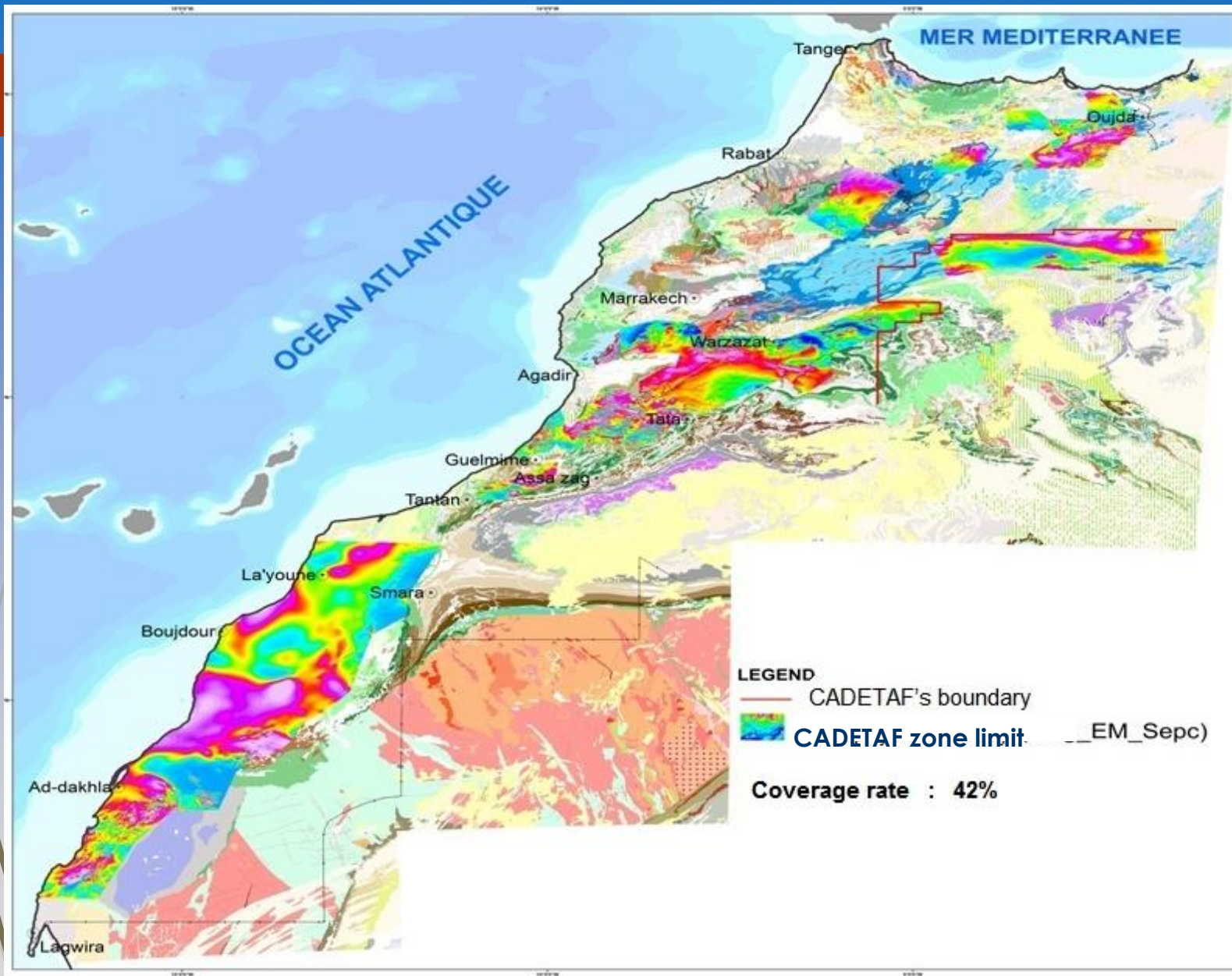
Status of geoscience infrastructure until 2014



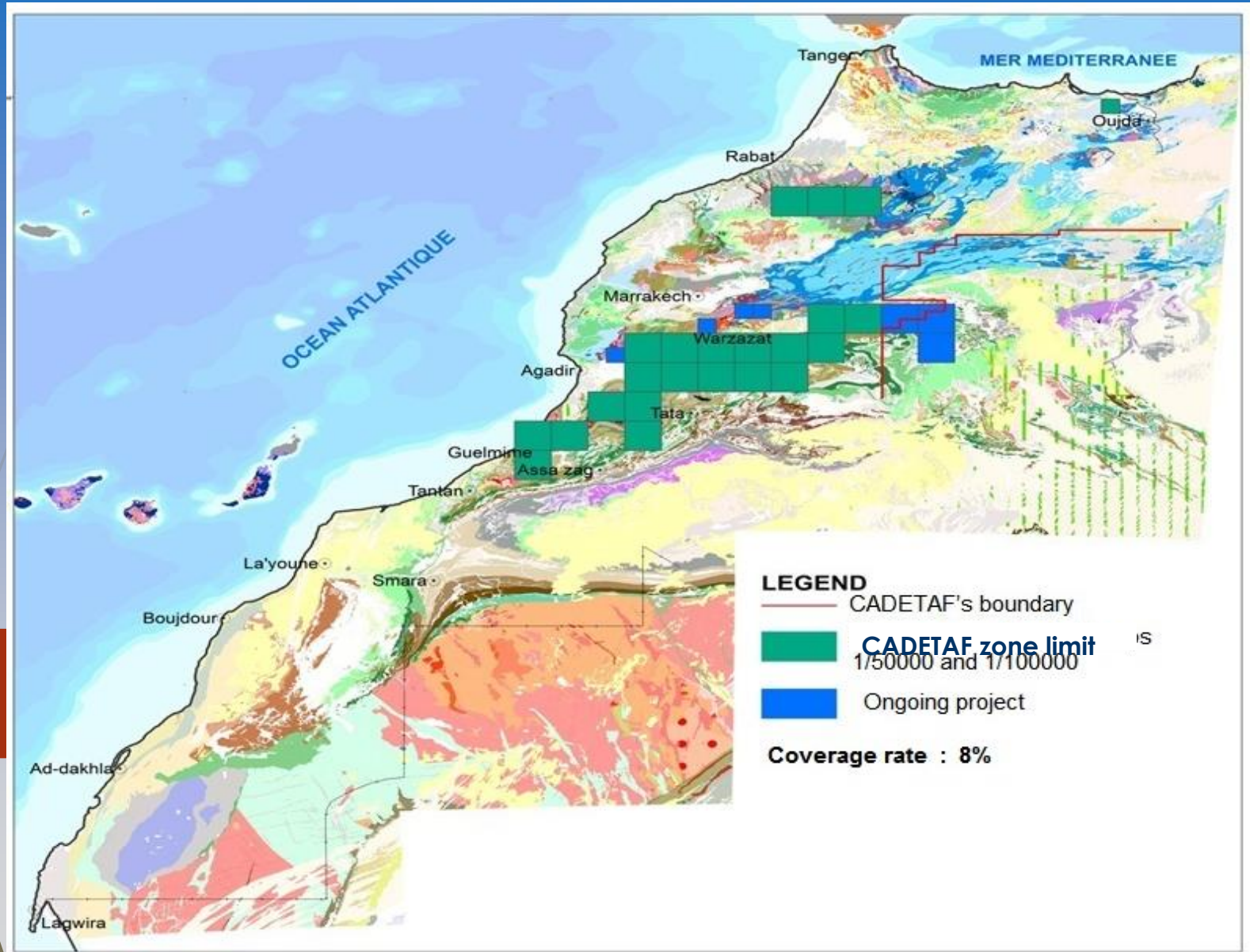
Status of the geological infrastructure up to 2014

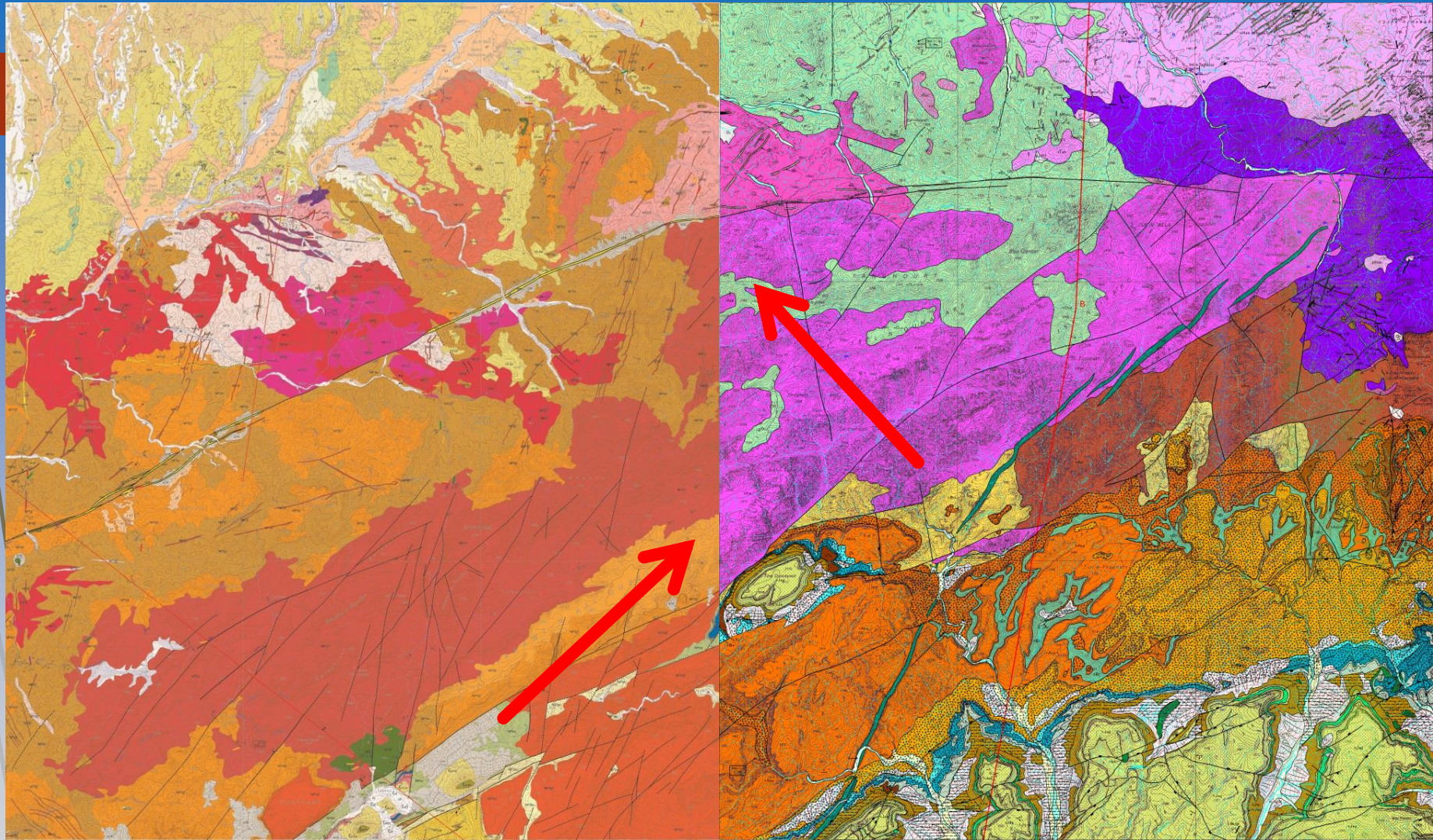


Status of the geophysical infrastructure up to 2014



Status of the geochemical infrastructure up to 2014





The contours of the geological formations of two adjacent boards don't comply

Issues and levers improvement

Issue No. 1

- Capitalize the craft and the skills of human resources in the geological field and its applications.

Issue No. 2

- Ensure the development of geological infrastructure and national geothematic.

Issue No. 3

- Promote the discovery of mineral and energy resources.

Issue No. 4

- Facilitate decision-making based on evidence concerning the development of land and infrastructure security.

Issue No. 5

- Process, manage and distribute information.

Issue No. 6

- Protect and promote the national geological heritage.

level 1-1

Seat an involvement and responsabilisation framework of our Human Resources:

- **Action 1.1.1:** Provide a work organization where, for each task are identified and appropriate skills profiles;
- **Action 1.1.2:** Establish a working team approach where coaching, exchange and transfer of knowledge and experience are assured.

level 1-2

Ensuring the motivation and blossoming of our human resources:

- **Action 1.2.1:** Ensuring favorable working conditions by setting up logistical and financial means meeting the needs of defined issues;
- **Action 1.2.2:** Human resources benefit to training modules with the aim to build and develop specialized profiles.

Level 2-1

Strengthen and increase the scope of coverage in geological mapping, geophysical, geochemical and synthesis maps:

- **Action 2.1.1** Elaborate a procedure manual capitalizing on acquired experiences;
- **Action 2.1.2** Establish a priority mapping program;
- **Action 2.1.3** Progressively retake production of geological mapping by the means starting with the completion of geological mapping pending initiated by former geological regional centers;
- **Action 2.1.4** Prioritize areas promising mineral potential and that the current status the geological infrastructure and geothematic handicap their promotion;
- **Action 2.1.5** Promoting cooperation in the field of geological mapping with partners, operators, academics and national and international academicians researchers;
- **Action 2.1.6** Create a scientific committee of geology for Morocco for the assessment of cartographic production.

Level 2-2

Intensify geological knowledge of the country through the exchange and sharing of data and Geoscientists

- **Action 2.2.1** Coordinate all geological research carried out on national territory;
- **Action 2.2.2** Working with academic partners, national and international scientific institutions to develop programs and interdisciplinary research in the fields of geoscience;
- **Action 2.2.3** Resume Editing and publication of Notes and Memoirs and unpublished reports from the Directorate of Geology.

Lever 3-1

Increase knowledge and visibility of potential mineral resources, with a view to ensuring growth of the mining sector's contribution in the national economy:

- **Action 3.1.1** Increase knowledge of orogens and geodynamics;
- **Action 3.1.2** Undertake studies on promising metallogenic prospects and integrate them into the geological mapping and geochemical targeting indices and anomalies detected;
- **Action 3.1.3** Working with academic partners, national and international scientific organizations to increase the knowledge of the mineral potential of our country;
- **Action 3.1.4** Elaborate periodically metallogenic provinces synthesis maps updated with the location and description of the new prospects and mining indices;
- **Action 3.1.5** Capitalize and develop, in collaboration with partners, mining a database for better attractiveness of investors in the field of prospecting and mineral exploration.

Lever 3-2

Provide regional geoscience data of our basins to support oil and gas exploration:

- **Action 3.2.1** Increase knowledge of geodynamics of our sedimentary basins;
- **Action 3.2.2** Working with academic partners, national and international scientific organizations to conduct studies mainly sedimentological, stratigraphical and paleoenvironmental reconstruction to increase awareness on the potential of our source rocks in basins, reservoir rocks and potentially tricky structures;
- **Action 3.2.3** Establish, in collaboration with partners, an oil database.

Level 4-1

Ensure that decisions on territory planning, are based on a proper understanding of the regional geology, rocks resources and industrial materials, in particular, potential geological hazards:

- **Action 4.1.1** Identify and describe in the explanatory notes of the geological maps, the potential for construction materials and industrial and ornamental rocks of mapped areas;
- **Action 4.1.2** Elaborate the synthesis updated maps on the regional potential in building materials and industrial and ornamental rocks;
- **Action 4.1.3** Capitalize and provide probative geoscience information for decision-makers in development and for the small and medium sized company in this sector;
- **Action 4.1.4** Establish, with partners, national and even local regional scientific studies related to geological hazards and instability of the soil and subsoil;
- **Action 4.1.5** Provide the geological maps with a detailed background of geological cuts near fault zones, shear zones, clay and bedrock outcrops karsts and potential.

Lever 5-1

Ensure efficient collection and data processing:

- **Action 5.1.1** Develop tools and appropriate software for digitizing, scanning, data entry, processing and cross-checking of data;
- **Action 5.1.2** Building a databases of the Directorate of Geology and ensure its regular updating.

Lever 5-2

Provide easy and fast access to data and knowledge of the DG:

- **Action 5.2.1** Develop a Geographic Information System (GIS) interoperable and to which access will be through the website of our ministry (www.mem.gov.ma);
- **Action 5.2.2** Providing this GIS with secure IT infrastructure, broadband and adaptable to new technologies.

Lever 5-3

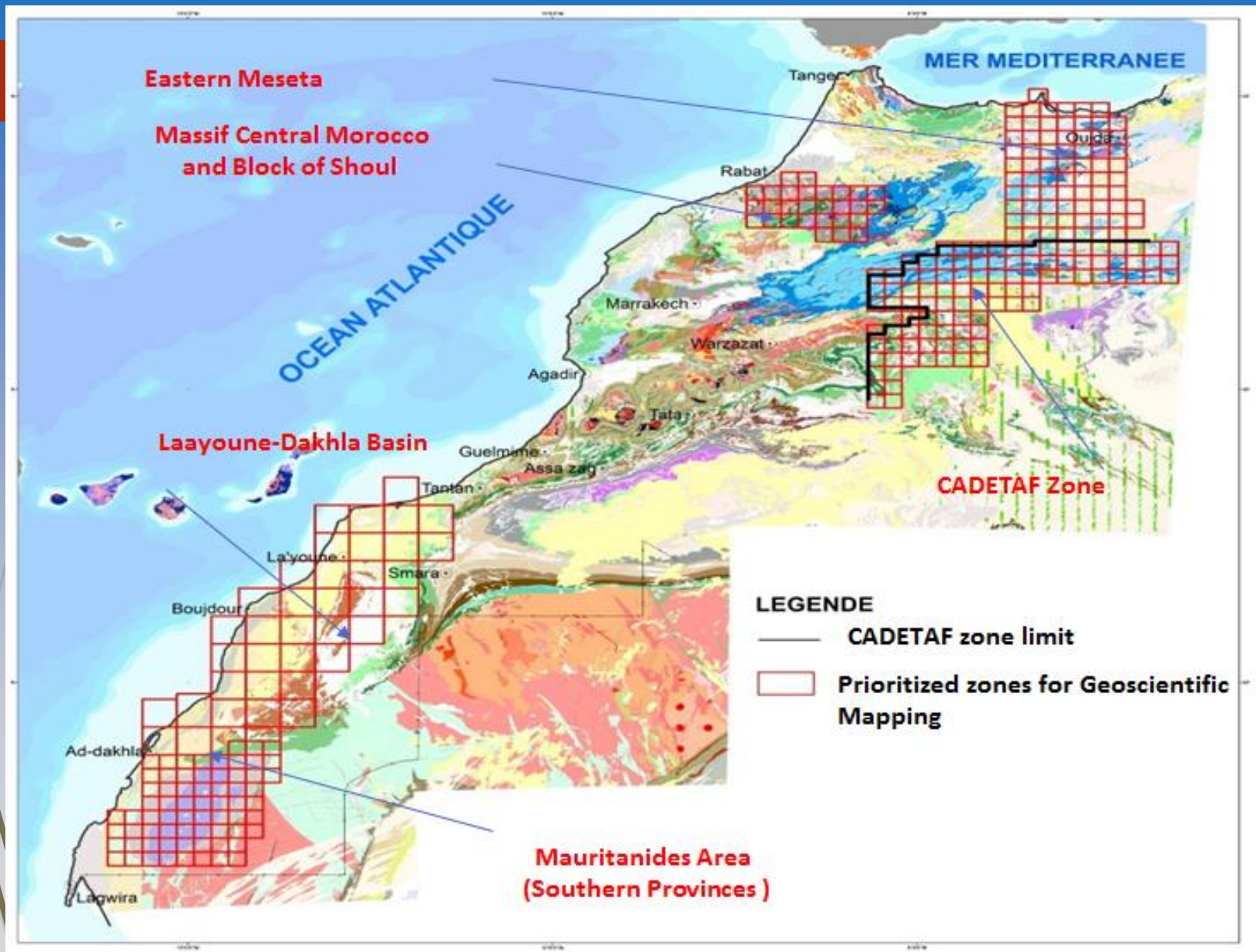
Ensure the integrity and accessibility of physical information resources:

- **Action 5.3.1** Define the modalities for promoting access to map libraries, documentation, data archives, reports;
- **Action 5.3.2** Setting up a library for major facies, and formalize its management and operation;
- **Action 5.3.3** Work towards the establishment of a library of thin sections and polished sections describing the main microfacies of our heritage.

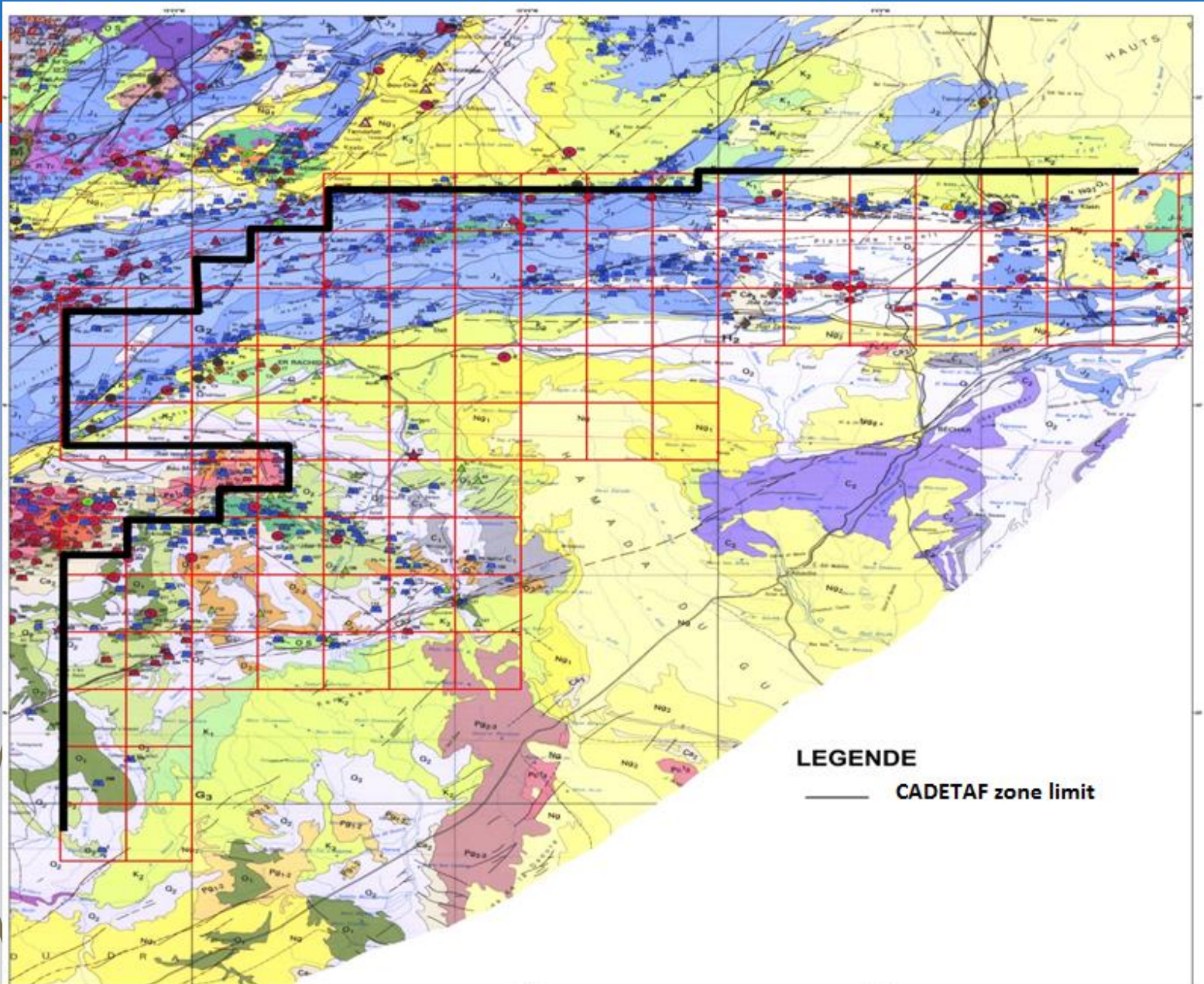
Lever 6-1
Implementation of measures to
qualify geological heritage as
one of the regional economic
development vectors:

- **Action 6.1.1** Activate the finalization of the draft text regulating the protection of national geological heritage;
- **Action 6.1.2** Promote and value, in collaboration with the parties concerned, the national geological heritage by creating Geopark area, encouraging the development of geotourism and geological guides;
- **Action 6.1.3** Maintain and enrich collections mineralogical, petrographic, paleontological and micropaleontological of the Ministry of Energy, Mines, Water and Environment.

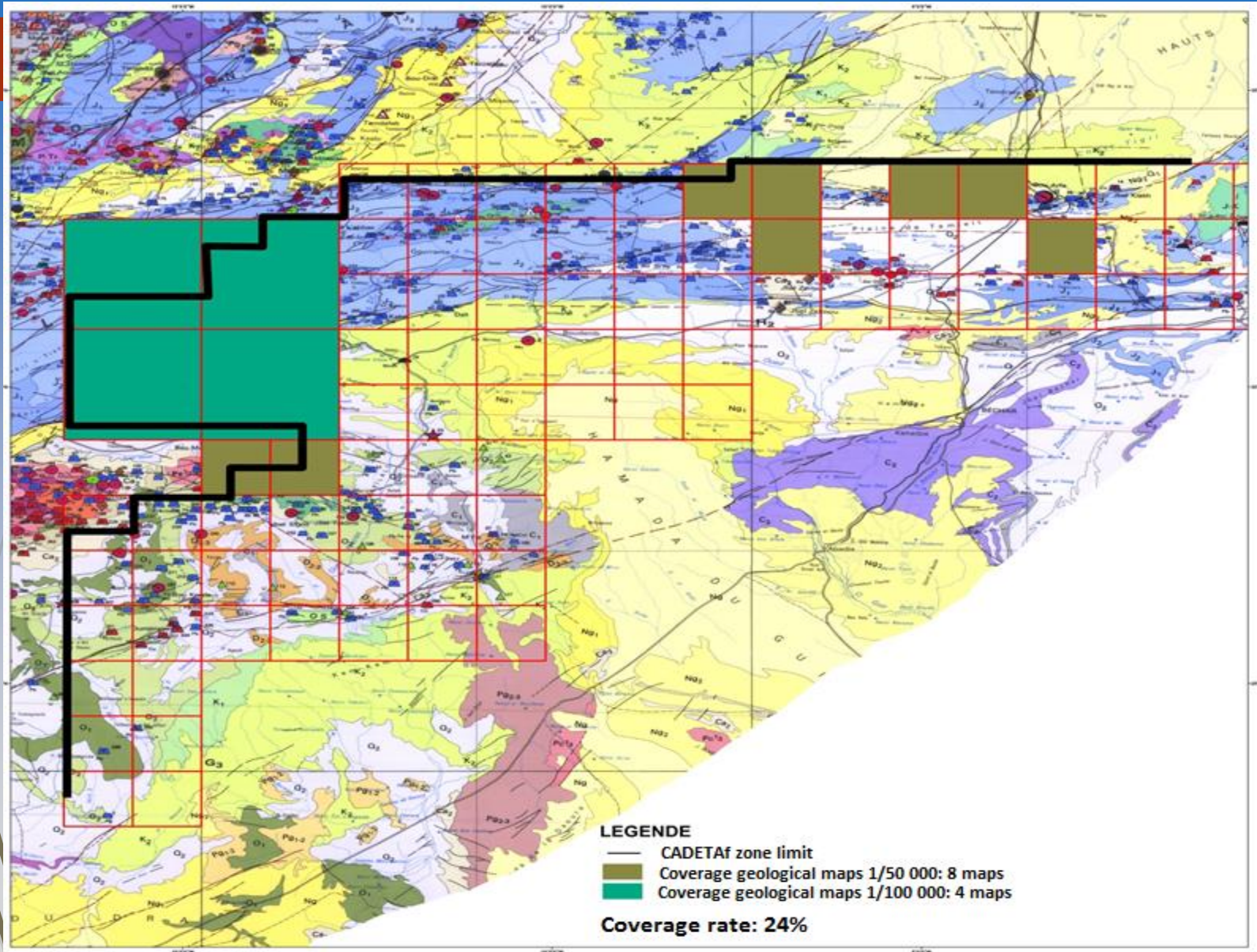
Prioritized zones for Geoscientific Mapping



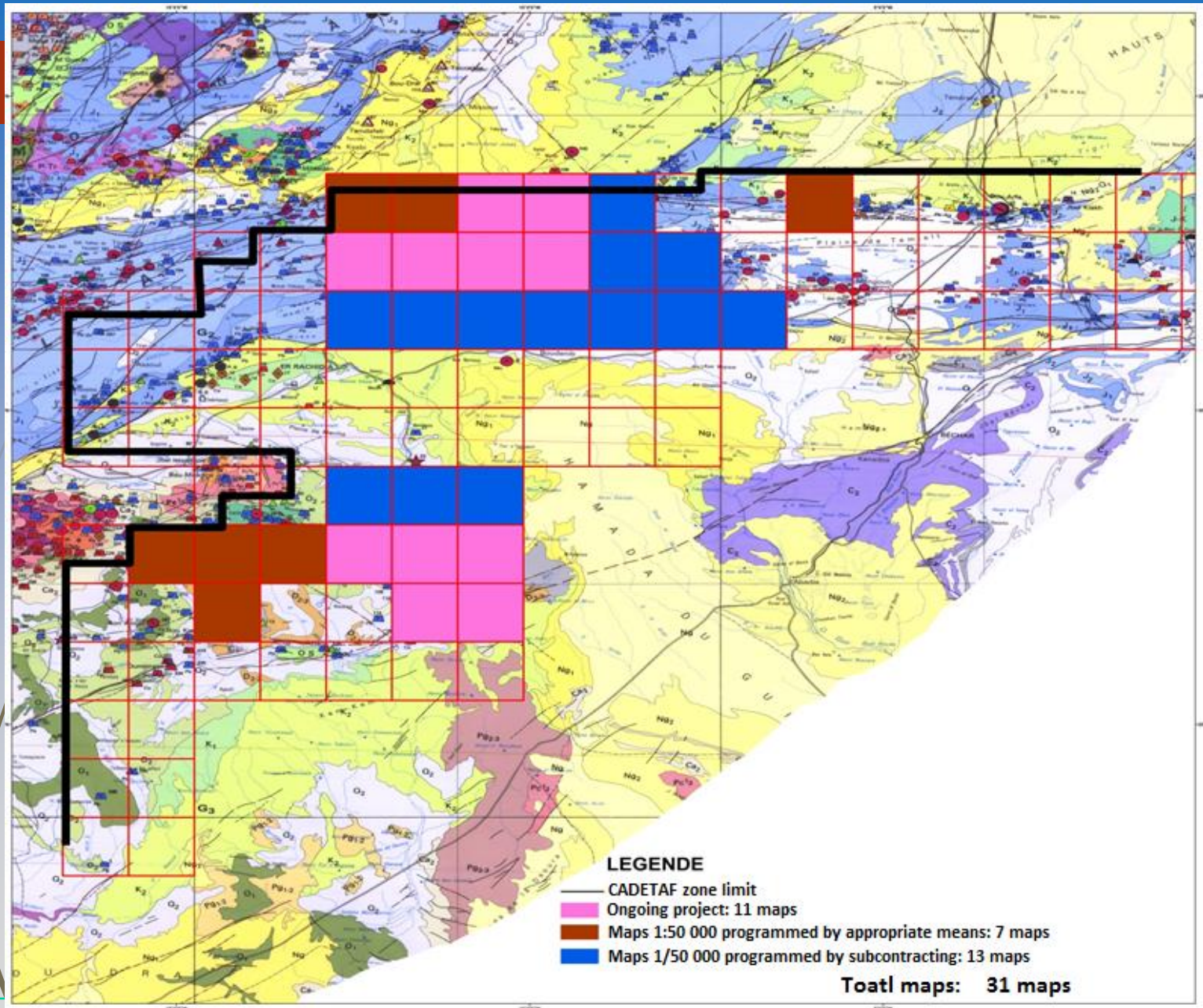
CADETAF area: Eastern High Atlas Tafilalet Maïder



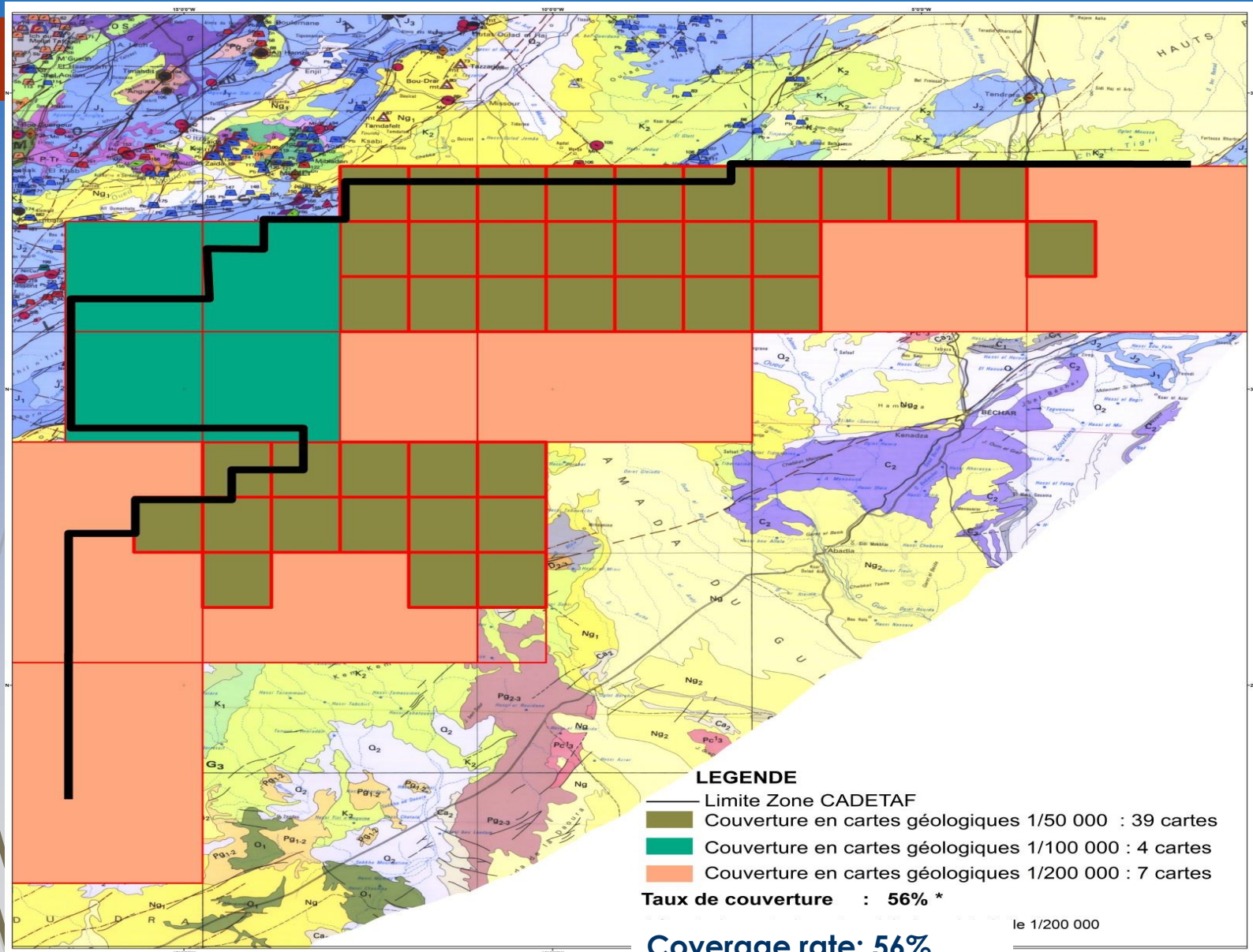
CADETAF zone: Status of the geological infrastructure up to 2014



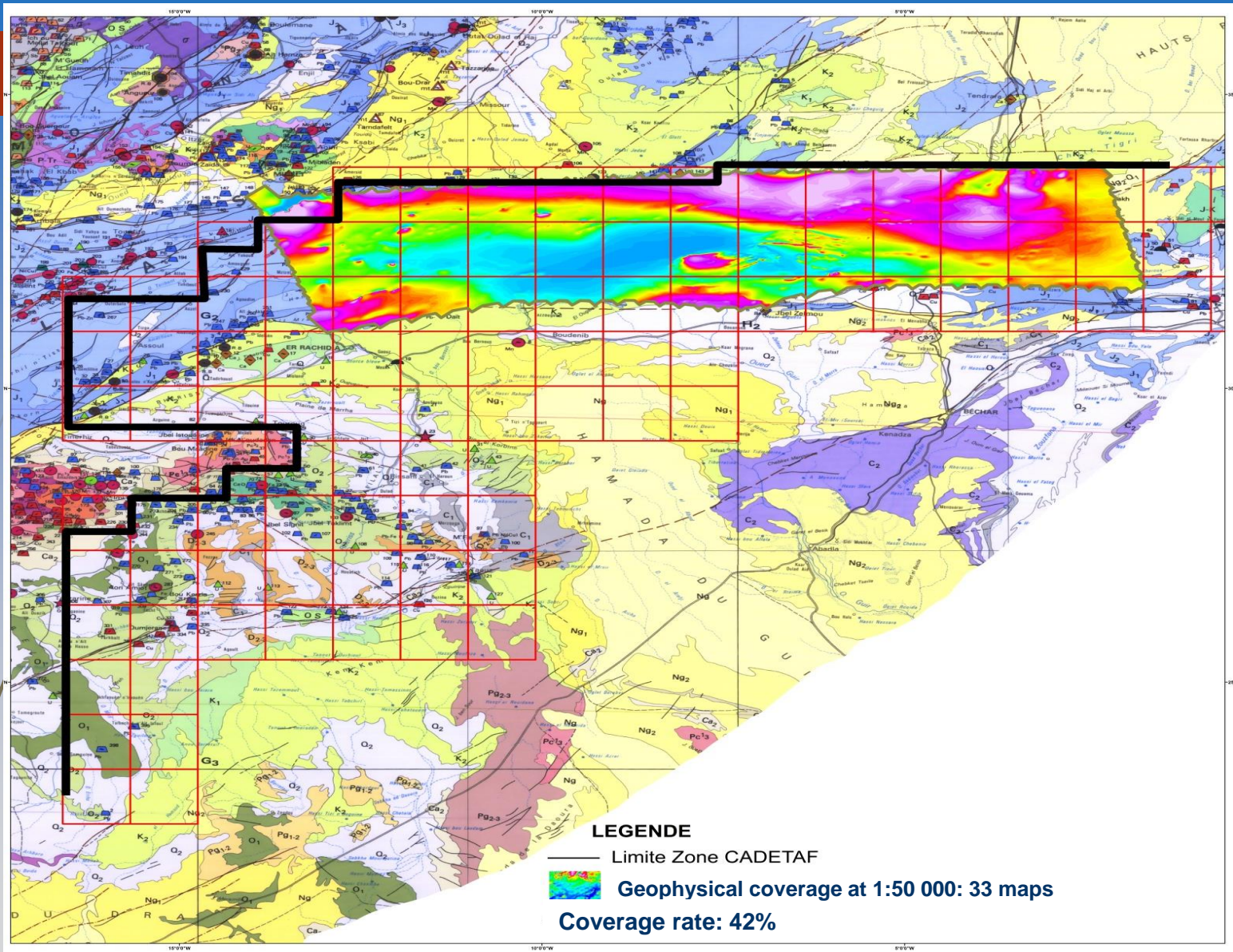
CADETAF zone: Programmed geological maps



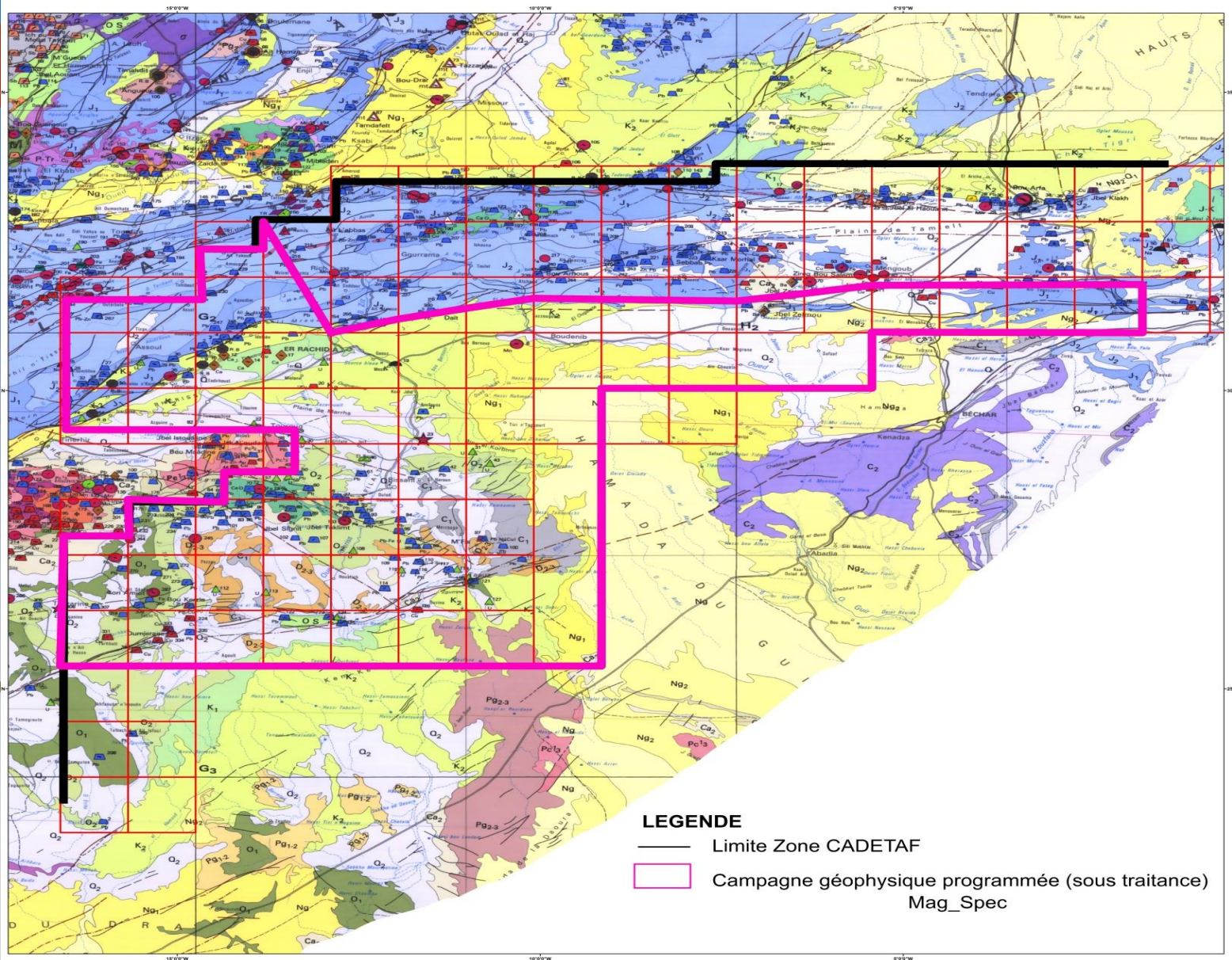
CADETAF zone: Status of geological infrastructure 2025



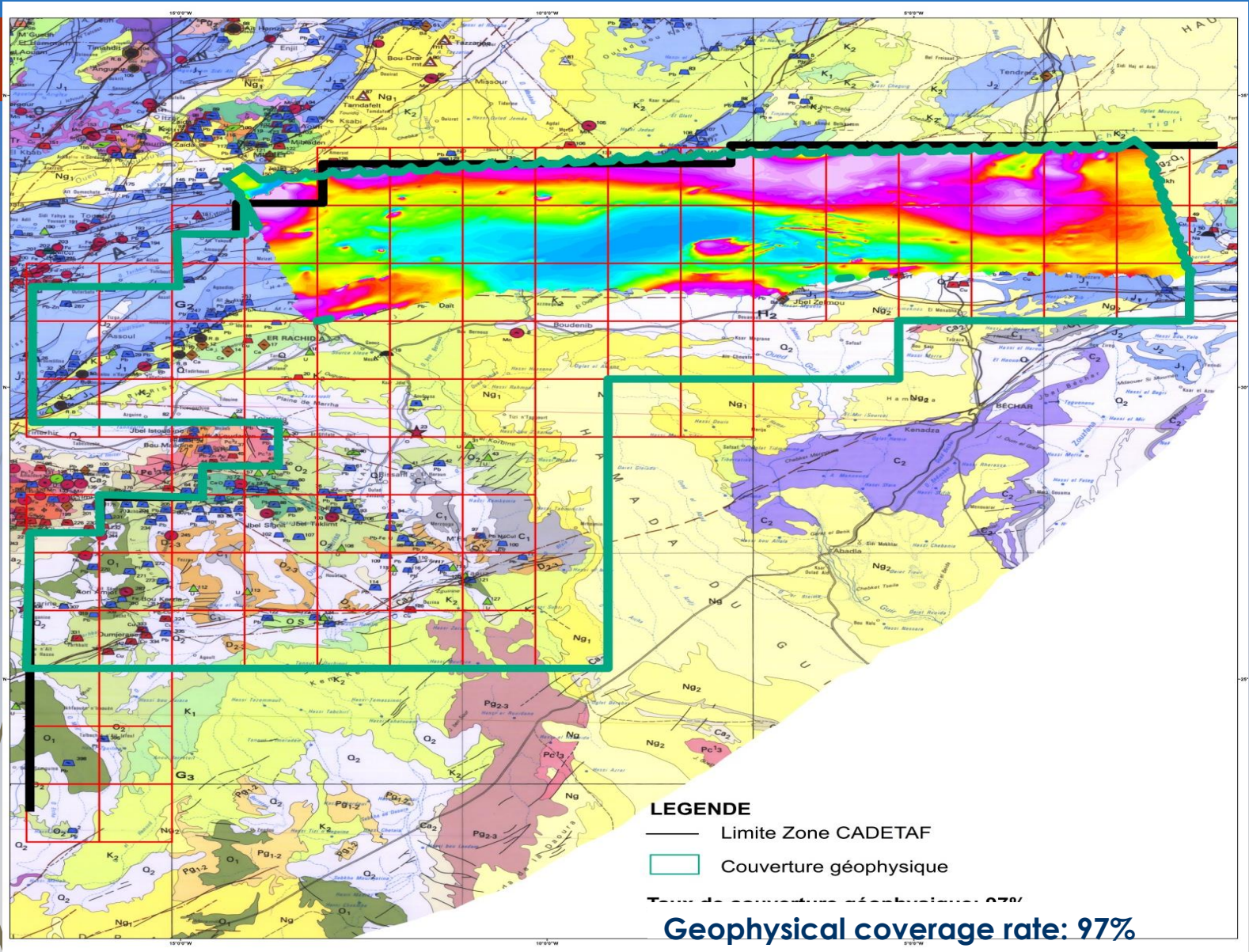
CADETAF zone: Status of geophysical infrastructure up to 2014



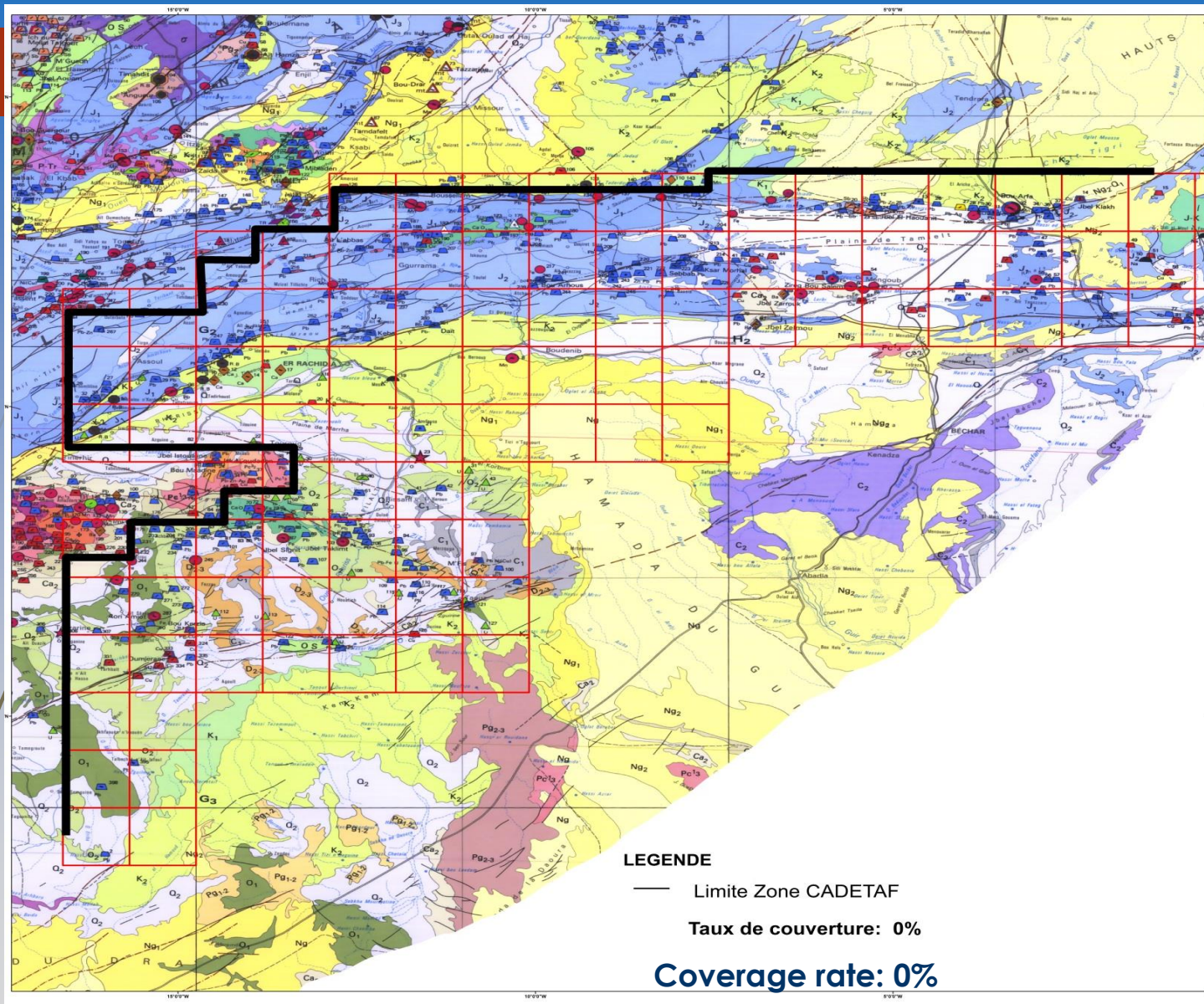
CADETAF zone: Programmed geophysical survey



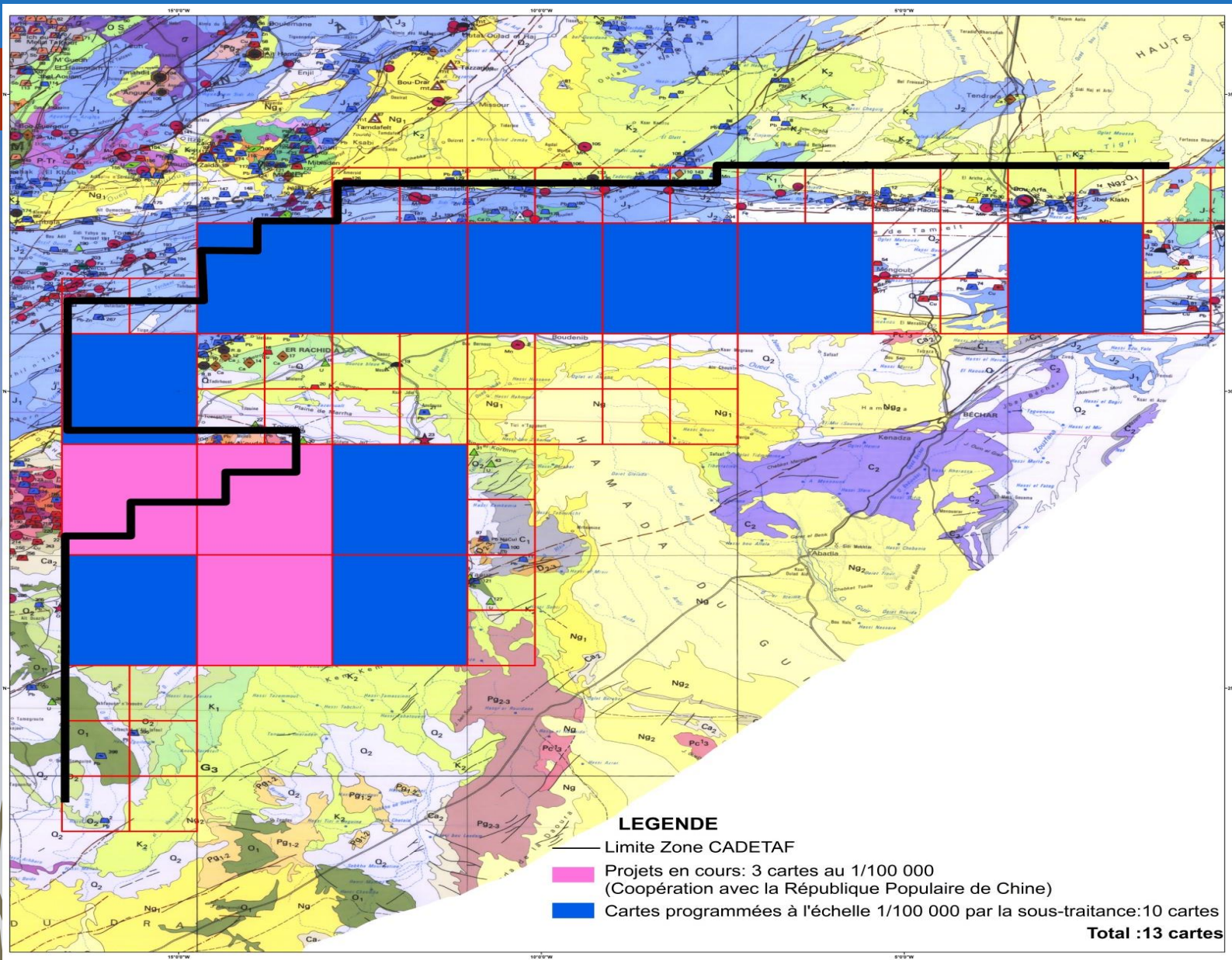
CADETAF zone: Status of geophysical infrastructure 2025



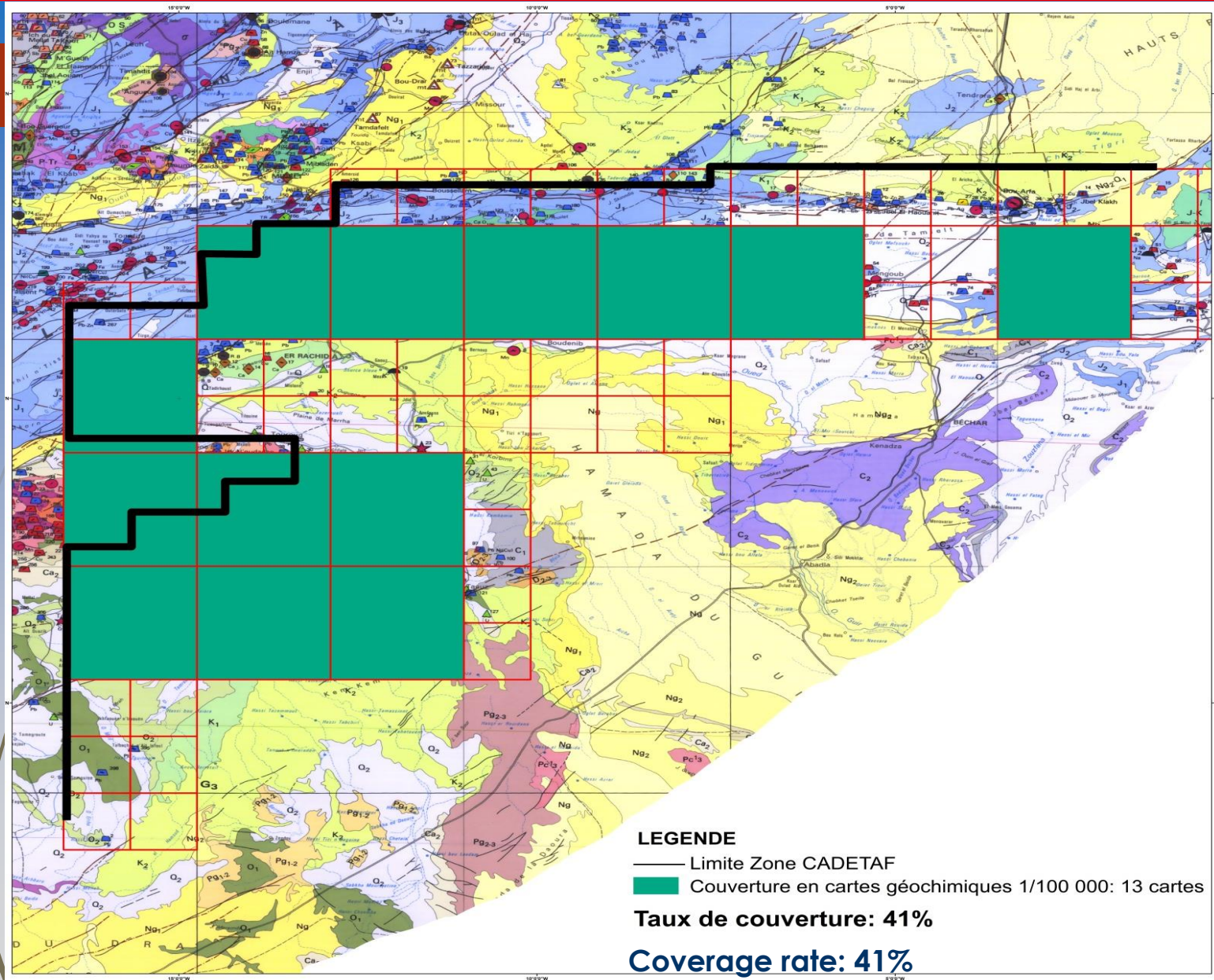
CADETAF zone: Status of geochemical infrastructure up to 2014



CADETAF zone: Programmed geochemical maps



CADETAF zone: Status of geochemical infrastructure 2025



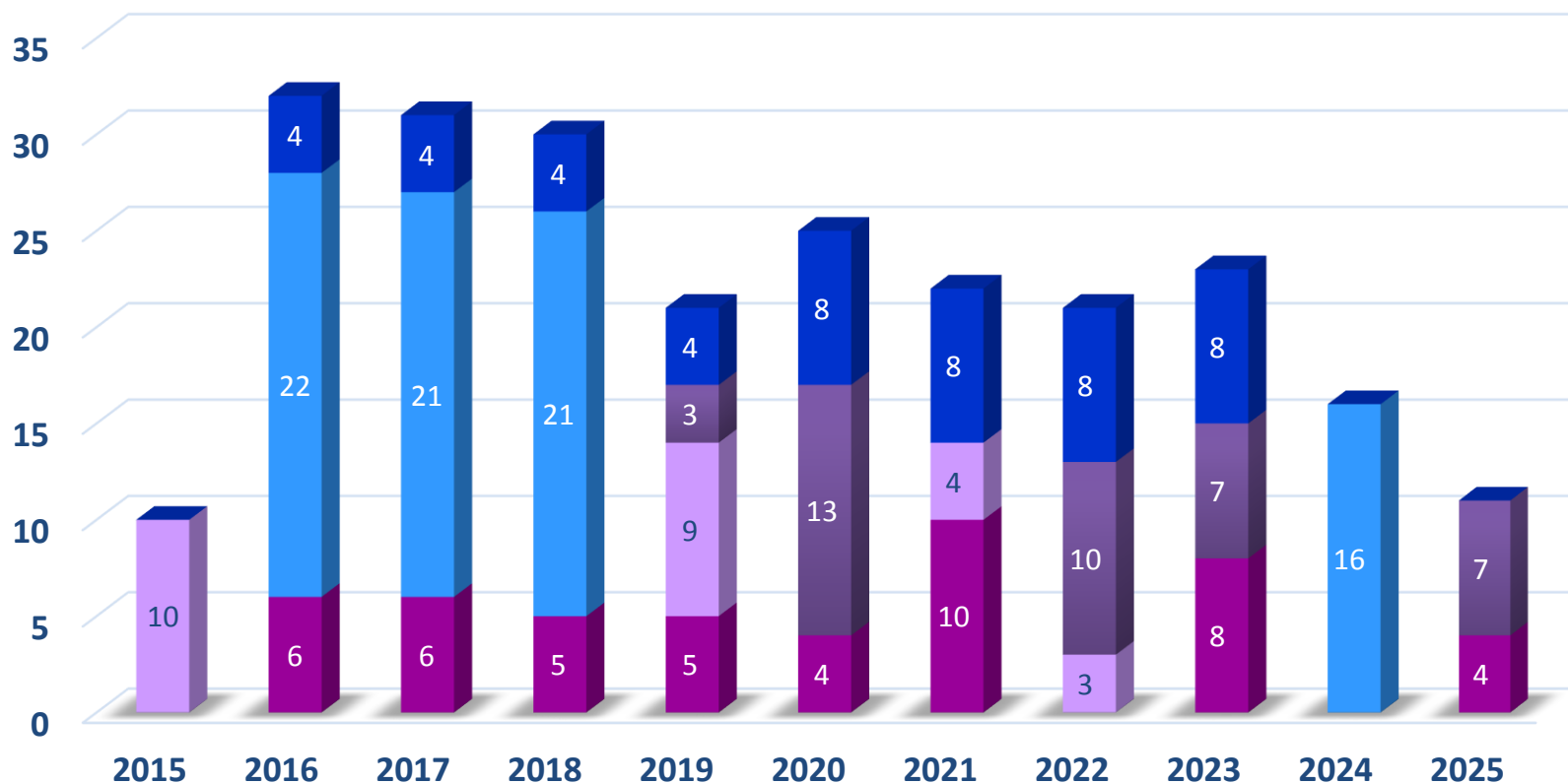
Geoscientific mapping: CADETAF area

Mapping	Scale	Realized maps		Ongoing maps	Programmed maps			Coverage rate		Budget in MDH		
		Analogic	Vectorial		Maps to vectorize	Maps to realize		2014	2025			
						Own means	Subcontracting					Cooperation
Geological	1/50 000		8	11		7	13		24%	56%	Subcontracting	19.5
	1/100 000	4			4				Eastern High Atlas		Own means	4.2
									49.5%	77.3%	Vectorisation	0.3
									Tafilalt Maïder		24.0	
								10%	70%			
Geophysical	1/50 000		33	-			64 (92213Km-L)		33%	97%		49.7
Geochemical		0		3 Cooperation			10		0%	41%		25.0
									Eastern Haut Atlas			
									0%	60%		
									Tafilalt Maïder			
								0%	100%			
Total											98.7	

Development project of Database and GIS at the Directorate of Geology

Chronology of actions	Programmed action	Intervenor	Year
1 st action (started)	Counting of structures and data collected under the project Goeforma in light of this counting, a set of data proves recoverable.	Own means	2015
2 nd action (started)	Recovery and maintenance of equipment.	Own means	2015
3 rd Action	Acquisition of the necessary software and hardware.	Subcontracting	2015
4 th Action	Constitution of managerial staff and technician team worked on this project and that the most part having been formed under the Geoforma project.	Own means	2015
5 th Action	Structure update of database of the Directorate of Geology.	Own means and cooperation	2015
6 th Action	Vectorization project of geological maps at 1/100 000 to 1/50 000 th realized before the launch of PNCG at a rate of 20 sheets per year.	Subcontracting	
	The expected goals through this vectorization are: <ul style="list-style-type: none"> ✓ The implementation of digital documents with the possibility of integrating them into the database of the Department of Energy and Mines; ✓ The standardization of data of these maps with those realized under the PNCG; ✓ Solving problems shifting the boundaries of formations and geological structures between different maps. 		2015
			2016
			2017
	Following this work, the cartographic product will be made a uniform product, in line with international standards of geological mapping and providing the ability to "surf" on all the mapped areas.		2018
7th Action	Establishment of thematic maps 1/250 000th of synthesis.	Own means	2015-2020
	All the geological maps will be available as a GIS Geoportal and dedicated to National Geological Service will be operational.		2020

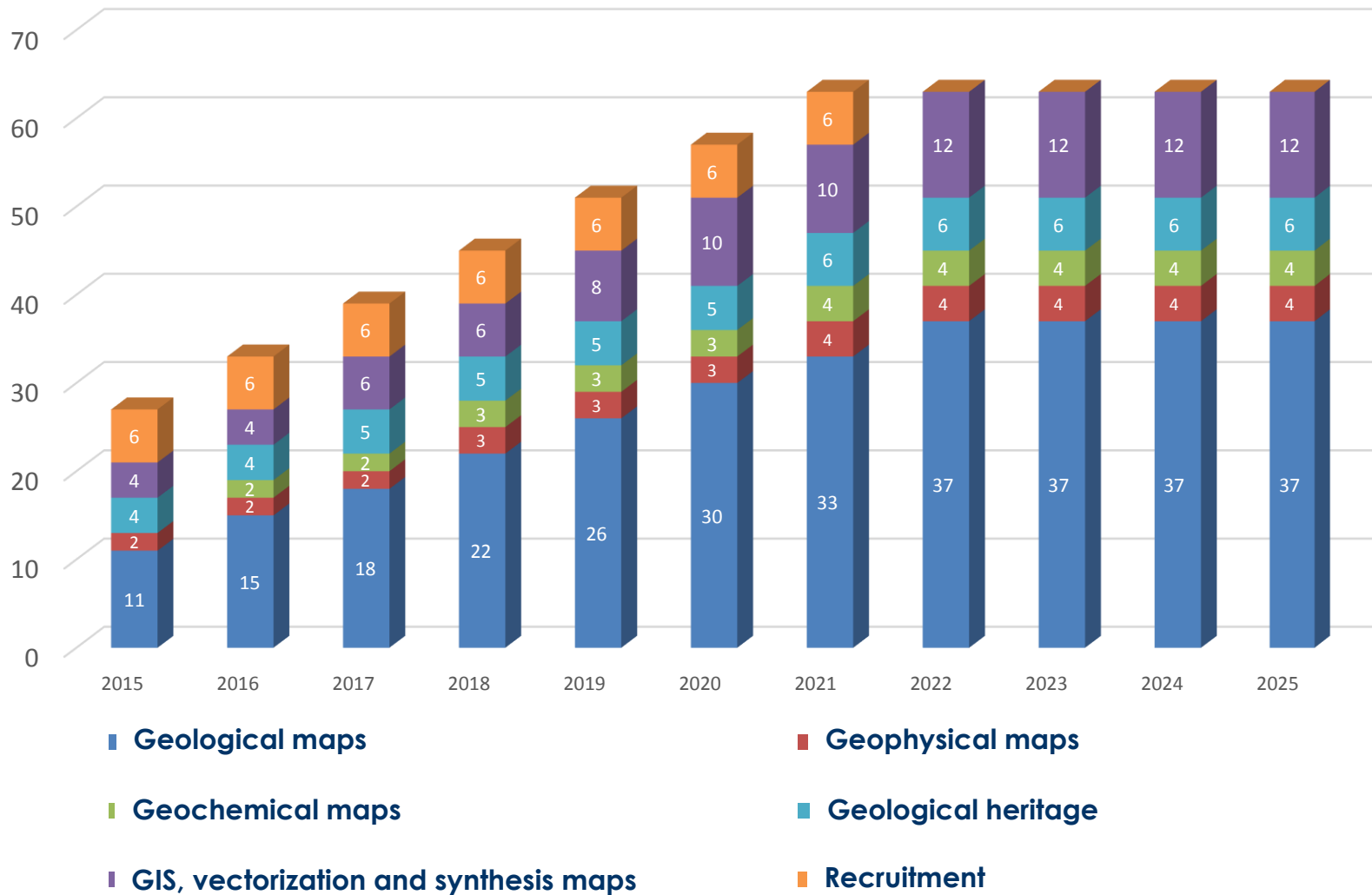
Distribution of number of maps programmed per year for the period 2015-2025



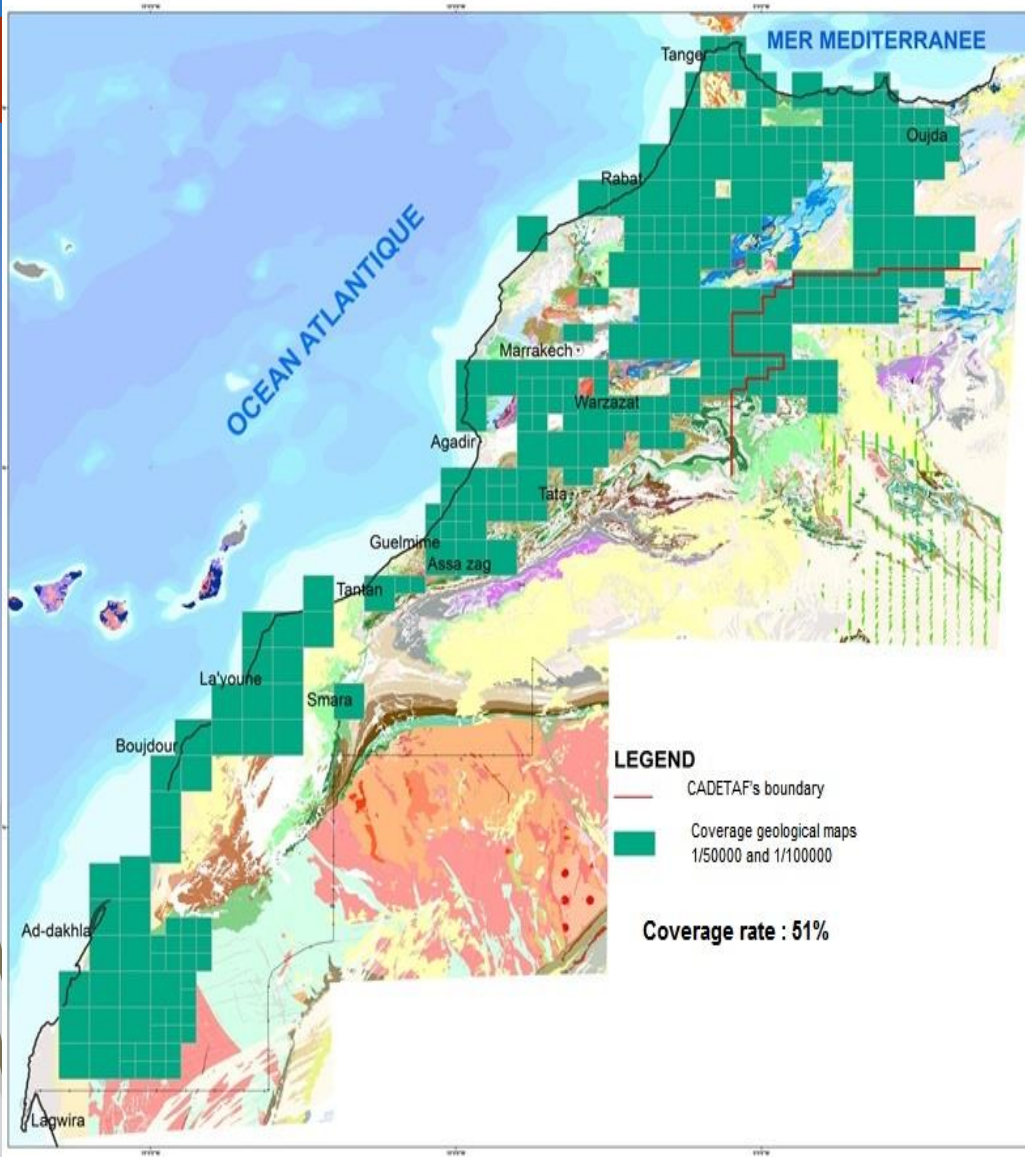
- Geological maps by own means
- Geophysical maps
- GIS and vectorization of maps

- Geological maps by subcontracting
- Geochemical maps

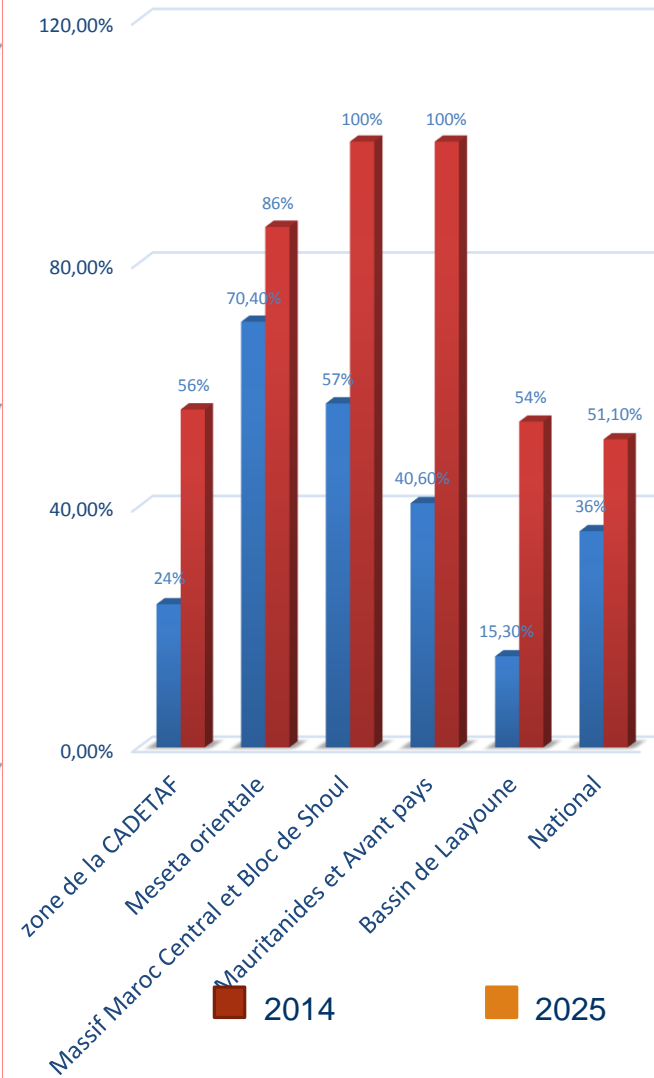
Human Resources: Managers and Technicians



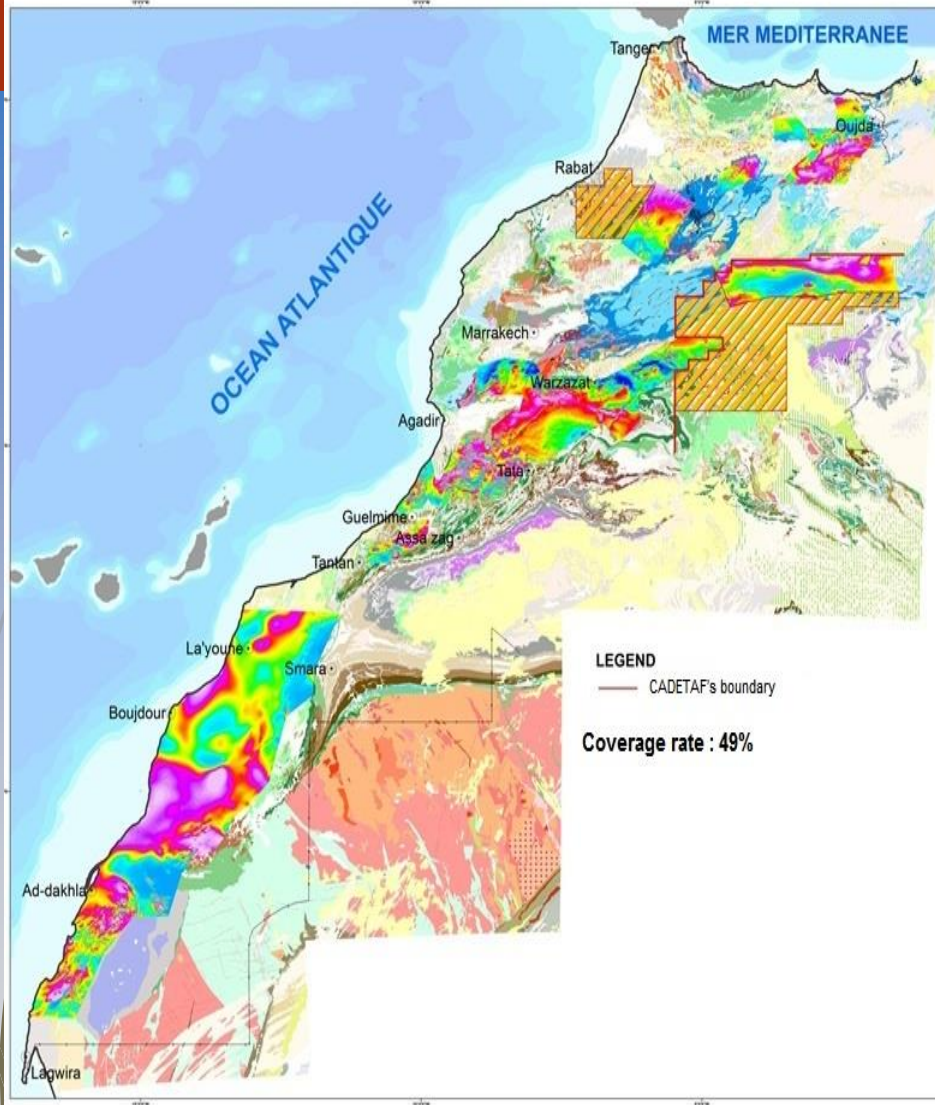
Status of the geological infrastructure at 2025



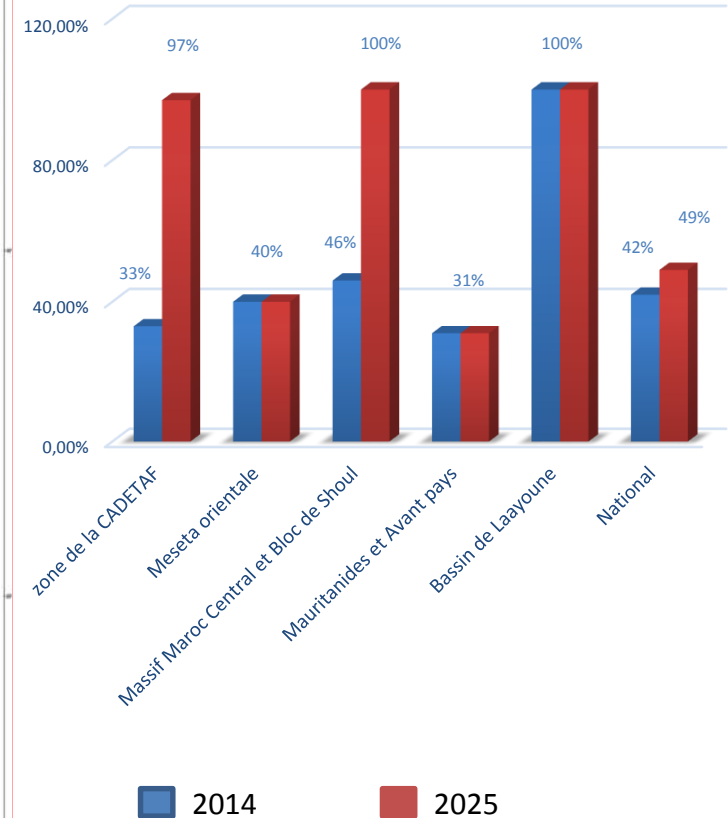
Rate change of the geological coverage for 2015-2025 period



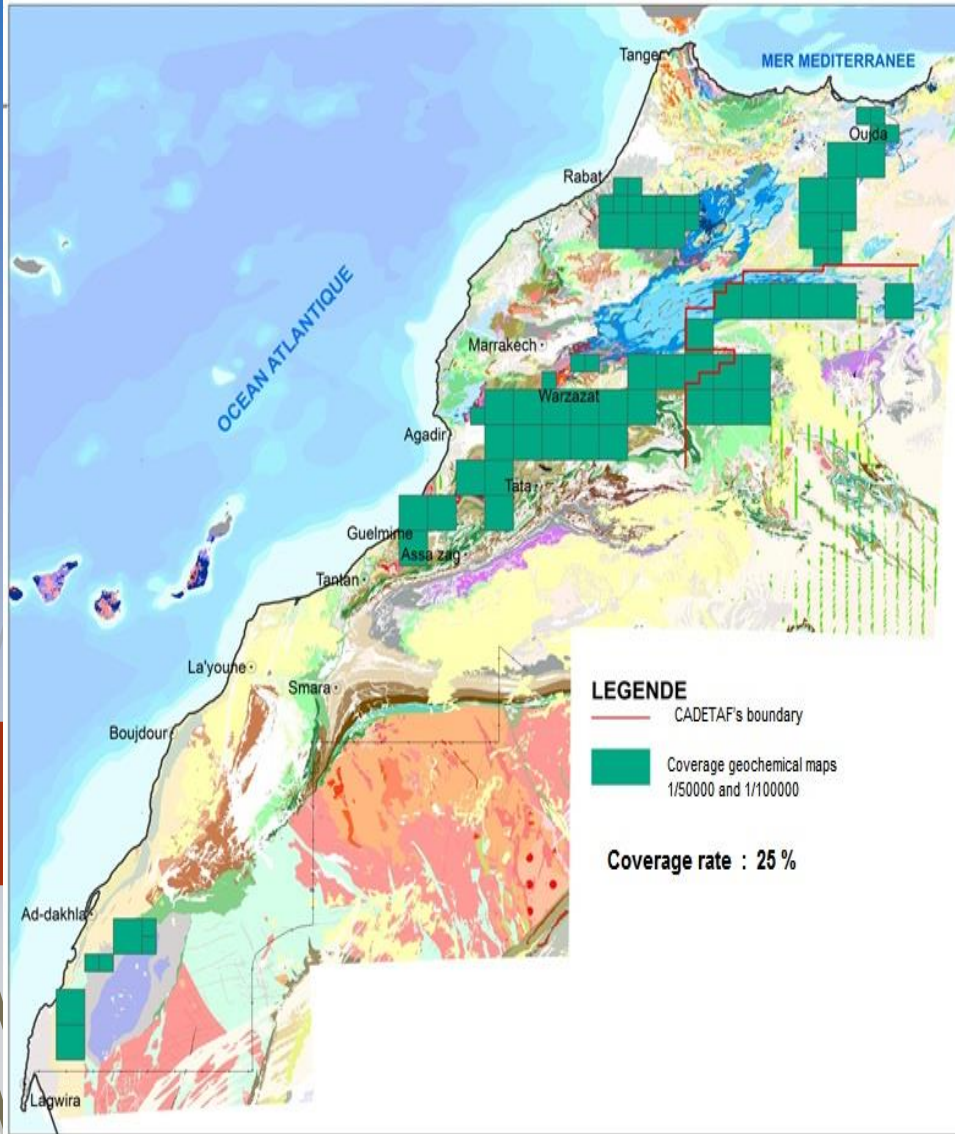
Status of the airborne geophysical infrastructure at 2025



Rate change of the geochemical coverage for 2015-2025 period



Status of the geochemical infrastructure at 2025



Variation du taux de la couverture géochimique période 2015-2025

