Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe

Technical review report for project FRAME

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement number 731166.

INTRODUCTION

Technical review report is part of GeoERA's Monitoring and evaluation process for co-funded projects (*hereinafter: project*). The aim of a technical review is to assess the work carried out under the project over a certain period and provide recommendations. Such technical review evaluates the project reports and deliverables, the proper use of resources, the management of the project and the expected impact.

Technical review report consists of four sections, each representing one level of monitoring and/or evaluation of the project:

Level	Monitor / Reviewer	Input	Aim
1 – Monitoring of progress indicators	Monitoring and reporting officer (GeoZS)	MPPR* FPPR**	Monitoring of the effectiveness of implementation of selected projects with respect to finance, time and administration.
2 – Scientific review	Reviewers (GeoZS)	Submitted deliverables MPPR FPPR	Quality review of the deliverables and review of achieving scientific and professional goals.
3 – Review of the theme progress	Theme coordinators	MPPR FPPR	Review of achieving theme objectives.
4 – GeoERA Progress evaluation	Stakeholder Council member(s)	Sections 1 and 2 of this report Review meetings	Overall project progress and general recommendations.

*MPPR = Midterm Project Progress Report (see PI doc no 2)
**FPPR = Final Project Progress Report (see PI doc no 2)

Monitoring and evaluation process:

M0 = End of reporting period
M1 = Submitted (Final) Project progress Report (MPPR / FPPR)
M2 = 1 – Monitoring & 2 – Evaluation
M3 = 3 – Evaluation of the theme progress
M3 = (Final) Review Meeting & 4 – Progress evaluation

Each project will be reviewed twice: for first project period M1-M18 – Technical review report, and second project period M19-M36 – Final review report.
Technical review report is based on Horizon 2020 templates but adopted to GeoERA needs. Technical reviews of projects shall be carried out on a confidential basis.

GENERAL INFORMATION

ERA-NET Cofund Grant Agreement:	731166
ERA-NET Cofund acronym:	GeoERA
Call identifier:	H2020-LCE-2016-2017/H2020-LCE-2016-ERA
Project full title:	Forecasting and Assessing Europe's Strategic Raw Materials needs
Project acronym:	FRAME
Project reference number:	GeoE.171.010
Project topic:	Raw Materials
Project specific topic:	RM4-Forecasting and assessing Europe's Strategic Raw Materials needs.
Lead partner:	LNEG Laboratorio Nacional de Energia e Geologia I.P. (The National Laboratory of Energy and Geology)
Project website:	https://geoera.eu/projects/frame2/

☐ Technical review report
☒ Final review report

Period covered	01/01/2020 – 31/10/2021
Review meeting date	13.12.2021, start at 13:30

Contributor:	Role:	Approved on:
Barbara Simić	Monitoring and reporting officer	13.12.2021
Aleksandra Trenchovska	Monitoring and reporting officer	13.12.2021
Emil Pučko	Scientific Reviewer	15.12.2021
Jasna Šinigoj	Scientific Reviewer	15.12.2021
Matija Krivic	Scientific Reviewer	16.12.2021
Antje Wittenberg	Theme coordinator	24.12.2021
Christoph Gauert	GeoERA Stakeholder	28.12.2021
David Ovadia	GeoERA Stakeholder	30.12.2021

1 LEVEL 1 – MONITORING OF PROGRESS INDICATORS

In this section the project is monitored "remotely" on the basis of the respective reports. This part is filled in by Monitoring and reporting officer with aim to monitor the effectiveness of implementation of the selected projects with respect to finance, time and administration, based on submited MPPR and FPPR.

	Yes	Partially (comment needed)	No
PROJECT MANAGEMENT			
Has the MPPR / FPPR report been submitted on time?	☒	See comment no. 1	☐
Have there been any changes in project partnership?	☒	See comment no. 2	☐
Has the project management been performed as required?	☒		☐
Has the collaboration between partners been effective?	☒		☐
Do you identify evidence of underperforming partners, lack of commitment or change of interest of any partners?	☐ (see comment)		☒
DELIVERABLES and MILESTONES			
Have the planned deliverables for the period been submitted on time according to timeline in Project Agreement?	☐	See comment no. 3	☒
Have the planned deliverables for the period been completed (from MPPR / FPPR, sheet 4)	☒		☐
Have any changes to deliverables occurred (type/ dissemination level)? (from MPPR / FPPR, sheet 4 and 5)	☐		☒
Have planned milestones been achieved for the reporting period? (from MPPR / FPPR, sheet 4)	☒		☐
Have the project partnership identify any difficulties achieving any of the deliverables / milestones?	☐		☒
DEVIATIONS (from MPPR / FPPR, sheet 5)			
Has the project partnership identify any deviations that will not affect projects outputs?	☐		☒
Have any deviations occur on the project, with impact on project outputs?	☒	See comment no. 4	☐

In case of deviations, have the project adopted corrective measures?	☒		☐
DISSEMINATION, COMMUNICATION			
Has the project adopted its dissemination plan?	☒		☐
Have the planned dissemination activities been completed for the reporting period? (from MPPR / FPPR, sheet 6)	☒		☐
Have the partners' disseminated project results and information adequately?	☒		☐
Is the project following dissemination plan?	☒		☐
Is the project interacting in a satisfactory manner with other GeoERA projects?	☒		☐
Is the project interacting in a satisfactory manner with national/international bodies?	☐	NA	☐

FINANCE			
To the best of your estimate, have the resources used been utilised for achieving the project? (according to MPPR / FPPR, sheet 9)	☒		☐
To the best of your estimate, have the resources used been in a manner consisted with the principle of economy, efficiency and effectiveness?*	☒		☐
Are there any major deviations in the budget consumptions from the financial plan? (zero consumption in M18; deviation from plan exceeding 20% in M36)	☒	See comment no. 5	☐
Are there any major deviations in the Person - Months consumptions from the plan? (zero consumption in M18; deviation from plan exceeding 20% in M36)	☒		☐
Are any budget modifications for the project needed? (from MPPR / FPPR, sheet 5)	☐		☒

***The principles of economy, efficiency and effectiveness**: refers to the standard of "good housekeeping" in spending public money effectively. Economy can be understood as minimising the costs of resources used for an activity (input), having regard to the appropriate quality and can be linked to efficiency, which is the relationship between the outputs and the resources used to produce them. Effectiveness is concerned with measuring the extent to which the objectives have been achieved and the relationship between the intended impact and the actual impact of an activity. Cost effectiveness means the relationship between project costs and outcomes, expressed as costs per unit of outcome achieved.

Comments (highlighting the project progress) / deviations / recommendations:

The FRAME project addressed critical raw materials, following the EU Commission's concerns about the sustainable procurement of crucial raw materials for industrialised Europe. In order to gradually increase the supply of "green" energy, high-tech metals are needed that are extracted or refined from minerals on which Europe is heavily dependent on imports. The European Union has addressed this in the Raw Materials Initiative, subsequent Communications and the List of Critical Raw materials. Many national geological services have assisted the European Commission in identifying potential shortages of critical raw materials and provided information on how to overcome physical shortages. However, there was still a need for a homogeneous map. The project consortium addressed the question of where undiscovered critical mineral resources were likely to exist and how many undiscovered mineral resources might exist." The FRAME project updated datasets from the completed ProMine, Minerals4EU, EURARW (7th Framework Programme), European Geological Data Infrastructure (EGDI) and SCRREEN and ORAMA (Horizon 2020) projects; it worked closely with MINDeSEA, other GeoERA raw materials projects and GIP -P. Given the expertise, enthusiasm and commitment of the participating consortium members and the link to EGS members through MREG, FRAME has made a significant and successful attempt to further unlock the mineral potential for a renewed extractive sector in Europe as a driver for domestic raw material value chains. The partnership will continue project activities after the end of the project.

The Covid 19 epidemic has impacted the progress of the project FRAME. In December 2020, the project was extended by 4 months, from 30.6.2021 until 31.10.2021. The postponed project activities were appropriately communicated to the GeoERA Executive board, which has reviewed and approved the changes in terms of achieving the project outcomes. A detailed list of changes is part of the project documentation in the Project plan History of changes.

The project management structure was well defined and efficient. The pandemic impacted the project by limiting travel and field trips, resulting in fewer meetings and unspent budgets in the travel category. The project consortia achieved all set objectives and outcomes, and even added more services to its already extensive list of deliverables, although the final financial balance shows unspent funds; 87.0% was spent by the partnership. During project implementation period, partners BRMG, NGU and RBINS increased their budget, while partners GEOINFORM, GSI, GTK and LNEG decreased it. The project did not identify any underperforming partners that could affect the quality of the project outputs.

Communication and dissemination activities focused on decision-makers, policy-makers and the scientific community, reaching them through presentations at congresses and the general public via social media.

Comment no. 1: The Final Project Progress Report was submitted on time in draft form. Partners still have the opportunity to recalculate their financials by the end of the calendar year to include the final data, so minor variances can be expected. The changes will not affect the content of the project.

Comment no. 2: During the implementation of the project there were changes in the partnership: partner 3 IGME-Gr Institute of Geology and Mineral Exploration was renamed to partner HSGME Hellenic Survey of Geology and Mineral Exploration. Later, Project lead IGME-Sp Geological Survey of Spain was integrated into CSIC Agencia Estatal Consejo Superior de Investigaciones Científicas. In the second reporting period, the partner GBA joined the project consortium, with financial support from the lead partner LNEG. None of the above changes affected the project's ability to achieve its objectives and outputs.

Comment no. 3: Due to the pandemic situation, some activities were delayed, and deliverables had to be submitted later than planned. The revised dates were communicated to the Monitoring team and the GeoERA Secretariat by amending the project plan.

The deliverable changes in the project implementation period are:

Reporting period 1:
D2.2 postponed from M1 (31.7.2018) → M6 (31.12.2018)
D1.1 postponed from M3 (30.9.2018) → M5 (30.11.2018)
D1.2 postponed from M3 (30.9.2018) → M5 (30.11.2018)
D1.3 postponed from M3 (30.9.2018) → M5 (30.11.2018)
D4.1 postponed from M6 (31.12.2018) → M9 (31.3.2019)
D8.1 postponed from M6 (31.12.2018) → M14 (31.8.2019)
D8.2 postponed from M12 (30.6.2019) → M24 (30.6.2020)
D2.4.1 moved from M18 (31.12.2019) → M16 (31.10.2019)

Reporting period 2:
D3.5 postponed from M24 (30.6.2020) → M38 (31.8.2021)
D6.1 postponed from M24 (30.6.2020) → M35 (31.5.2021)
D2.5 postponed from M30 (31.12.2020) → M36 (30.6.2021)
D5.2 postponed from M30 (31.12.2020) → M32 (28.2.2021)
D6.2 postponed from M30 (31.12.2020) → M32 (28.2.2021)
D7.4 postponed from M30 (31.12.2020) → M33 (31.3.2021)
D3.3 postponed from M32 (28.2.2021) → M38 (31.8.2021)
D4.4 postponed from M32 (28.2.2021) → M34 (30.4.2021)

D5.3 postponed from M32 (28.2.2021) → M34 (30.4.2021)
D5.4 postponed from M32 (28.2.2021) → M36 (30.6.2021)
D3.4 postponed from M34 (30.4.2021) → M37 (31.7.2021)
D4.5 postponed from M34 (30.4.2021) → M39 (30.9.2021)
D5.5 postponed from M34 (30.4.2021) → M36 (30.6.2021)
D5.6 postponed from M34 (30.4.2021) → M36 (30.6.2021)
D6.3 postponed from M34 (30.4.2021) → M36 (30.6.2021)
D4.4 is deleted
D6.4 postponed from M35 (31.5.2021) → M39 (30.9.2021)
D2.3 moved from M36 (30.6.2021) → M6 (31.12.2018)
D1.6 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D2.4 is deleted
D2.6 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D8.3 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D8.4 postponed from M36 (30.6.2021) → M40 (31.10.2021)
D2.4 is added M40 (31.10.2021)
D2.5 is added M40 (31.10.2021)
D7.5 is added M40 (31.10.2021)

Comment no. 4: The pandemic situation affected FRAME in two specific WP's: WP4 - closed laboratories prevented generation of further analytical data. WP7 - restricted or no passenger traffic severely limited excursions to historical mine sites.

Comment no. 5: Some project partners spent 20% more than their planned budget, others spent less than 80%. The partner that has exceeded their budget is GSI. Partners that spent less than their planned budget are BGR, BRGM, HSGME, NGU and GBA. The consumption of man-months followed the EUR consumption.

The project has coped well with the negative external factors and has overcome its challenges in such a way that it has achieved its planned objectives and project results. For this reason, the project is rated "excellent" at level 1 and thus receives a rating of 4 - Objectives and targets fully achieved.

Overall assessment of the project:

☐ 5 - **Overachiever** (the project has achieved all objectives and goals for the period and has even exceeded expectations)

☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals for the period)

☐ 3 - **Good progress** (the project has achieved most of its objectives and goals for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has achieved some of its objectives)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives)

Summary of dissemination activities:

	SCIENTIFIC COMMUNITY	GENERAL PUBLIC	POLICY MAKERS	EUROPEAN INSTITUTION	NATIONAL INSTITUTION	REGIONAL INSTITUTION	INTERNATIONAL INSTITUTION	LOCAL INSTITUTION	PRIVATE COMPANIES	OTHER	Total
EVENTS	45540	160	43	10	3		5	35		25000	**70796**
MEDIA	50										**50**
MEETINGS	366			1			2				**369**
ONLINE_MEDIA	6000	248086		4							**254090**
PUBLICATIONS	147135	6100	1	1	1	1	1	1	1	147601	**300843**
Total	**199091**	**254346**	**44**	**16**	**4**	**1**	**8**	**36**	**1**	**172601**	**626148**

	ABSTRACTS	BLOG	CONGRESS	EXHIBITION	FACEBOOK	INTERNAL PROJECT MEETING	LEAFLET	LINKEDIN	MEETING	MEETING WITH OTHER GEOERA PROJECTS	NEWSLETTER	NEWSPAPER	NON SCIENTIFIC PUBLICATION	OTHER	PITCH EVENT	SCIENTIFIC PUBLICATION	SEMINAR	TWITER	WEBINAR	WEBSITE	WORKSHOP	YOUTUBE	Total
EVENTS			5	1										3	1		3		4		5		22
MEDIA								1															1
MEETINGS						1			1	5											1		8
ONLINE_MEDIA		14			88			6				1		1				14		20		2	146
PUBLICATIONS	16						1				16		1	10		17							61
Total	16	14	5	1	88	1	1	7	1	5	16	1	1	14	1	17	3	14	4	20	6	2	238

Are the dissemination activities adequate?

☒ 5 - **Overachieved** (the projects dissemination activities have exceeded expectations)

☐ 4 - **Excellent** (the projects dissemination activities have fully achieved its expectations)

☐ 3 - **Good** (the projects dissemination activities are adequate)

☐ 2 - **Acceptable** (the projects dissemination activities are acceptable)

☐ 1 - **Unsatisfactory** (the project has failed to disseminate)

Cummulative financial statement:

	Person months	**Total eligible costs**	**Reimbursement rate**	**GeoERA contribution**	**In-kind contribution**
Plan	**424,00**	**3.014.316,65**	**29,7 %**	**895.251,87**	**2.119.064,78**
1st period consumption	191,44	1.117.793,20	29,7 %	331.984,58	785.808,62
2nd period consumtion	251,71	1.504.553,86	29,7 %	446.852,50	1.057.701,37
TOTAL	**443,15**	**2.622.347,06**	**29,7 %**	**778.837,08**	**1.843.509,99**

2 LEVEL 2 – SCIENTIFIC REVIEW

In this section the project is reviewed ”remotely” on the basis of the respective reports. This part is filled in by reviewer with aim to review the quality of the deliverables and review of achieving scientific and professional goals. Scientific review is based on submitted deliverables and reported Impact statement in MPPR/FPPR.

Impact statement (from MPPR / FPPR, sheet 8):

The objectives set out initially and the subsequent results obtained in the FRAME project were presented in several event types ranging from scientific fora/meetings/congresses, seminars, webinars and workshops where the interest shown was high. Given the expertise, enthusiasm and dedication of the participating consortium members and the link to EGS members through MREG, FRAME made a significant and successful attempt to further unlock the mineral potential for a renewed raw materials sector in Europe as a driver for domestic raw material value chains. Of the points to highlight, the following stand out: 1- FRAME represented a cohesive taskforce of scientists working together for common pan-European goals to mitigate the dependency of mineral resources from non-European sources; 2-FRAME created innovation in mineral prospectivity science with favourability mapping implementation; 3- FRAME recognised the importance and the recognition and establishment of metallogenic provinces for the strategic CRM; 4- FRAME produced comprehensive mineral deposits maps of the occurrences of REE, P, Li, Co, C, Nb and Ta in Europe; 5- FRAME made a significant review of Nb-Ta mineral deposits in Europe and in Africa; 6- FRAME increased by 60% the available data on battery critical elements (Li, Co, C) in Europe by interacting with MREG members; 7- FRAME undertook and accomplished comprehensive phosphate mineralization indices in Europe; 8- FRAME added unpublished geochemistry data of phosphate deposits; 9- FRAME made a review of the CRM (REE) deposits in Europe; 10- FRAME had a revitalized look at selected old mine sites; 11- FRAME augmented and updated pan-European data sets, namely EGDI; 12- FRAME worked together with the other Raw Materials projects, within the GeoERA Raw Materials topic, and produced composite maps in conjunction with them, one example being the land-sea EU cobalt mineralization. (A strong network was established among the FRAME, MINDeSEA, Mintell4EU and GIP-P projects to facilitate on-going support); 13- Together with GIP-P and MINTELL4EU projects implemented important issues in a global context of the overall system of information, which included a- FRAME integrated results through the EGDI Portal (metadata, structured and unstructured data (EU-MKDB architecture), and b- FRAME was instrumental in the improvement of the present harvesting system and its quality assurance.
FRAME has made sure that a “lighter scientific side” of the project results were also presented to the general public through the dissemination of short and informative Facebook, LinkedIn, Twitter and newsletter issues.
Because it is still too early to tell, FRAME expects the results achieved to disseminate quickly after the end of the project, reaching more of the scientific community, the

policy makers and strengthening its presence amongst the academic and civil societies.

Expected impact (from Project Agreement):

The EU have deemed critical raw materials a core topic and that shows from the work continuously carried out and funded, e.g. EIP on Raw Materials, CRM list, ERECON, M4EU, EuRare, ProSUM, ProMine and SCRREEN. Additionally, geopolitical events make the chosen elements vary and some of the elements not initially contemplated as critical may become strategic in nature. Their longevity on either of these “lists” or “labels” is a constant analysis of several factors at a particular point in time. The FRAME Consortium is continually working to update and improve the concept and data used in those EU programmes. An important output from the M4EU project is European Union Raw Materials Knowledge Base (EURMKB), and the Minerals Yearbook. The ProSUM project which has just finished at year end 2017 delivered the EU Urban Mine Knowledge Data Platform (EU-UMKDP), including also mining wastes. There are also national projects going on targeting the ore potential of CRMs at country level. EuRare has compiled an overview of REE metallogenetic belts in Europe. The European Commission[1]has already acknowledge SRM metallogenetic knowledge is crucial to a wide range of societal issues, including sustainability in the area of energy, minerals, water)EIP Raw Materials Strategic Implementation Plan), environmental monitoring, health and safety of citizens, and the development of secure infrastructure (natural hazards). The mineral resources sector is the source of a significant proportion of CRM on which the society depends on. It supports regional communities, creates employment, provides facilities and enhances services, including health, education and welfare, through its contribution to local, regional and national economies.
Access to STR and CRM is essential to industrial and social development and economic growth and wellbeing of Europe. Europe’s geology favours the formation of exploitable ore deposits for primary sourcing of many CRM and the project will highlight regions with greatest potential and thereby generate predictive targets and increase the exploration investments on best quality prospects. This will make a key action concerning the improvement of the pan-European critical minerals deposit and mineral-based waste database, ensuring that all available European data are current and have been checked for quality and accuracy at the national level, and to make them accessible in a seamless way to all users helping business and other stakeholders to optimise their investment. RM4’s FRAME (Forecasting and assessing Europe’s Strategic Raw Materials needs) is a critical look beyond the traditional CRM list taking into account the mineral expertise present in the project consortium and member states in order to impact generally on: 1. Develop an updated knowledge base based on existing and newly acquired data, 2. Define the state-of-the-art with regards these elements and minerals, 3. Inventory possible secondary sources of these elements and minerals in historic mine sites, 4. Develop new products that make visualization

of the data simpler, e.g. maps, 5. Develop new metallogenic models for CRM and strategic minerals and hence, 6. Develop predictability maps where possible, 7. Disseminate the knowledge base through a wide community of potential shareholders, European, national and regional policy makers, exploration companies and the general public, 8. Significantly contribute towards a common spatial data platform and one-stop-shop for verified, quality minerals data. The main impacts already referred to in the Scientific Scope of the Call are reinforced by specific impacts of project FRAME - Forecasting and assessing Europe's Strategic Raw Materials needs:
• Continuously reinforced synergy at international level and reduced fragmentation of raw materials research and associated innovation efforts across Europe facilitating a more efficient use of natural resources, minimizing waste and improving recycling; o WP 2 and WP 3 will facilitate the generation of a holistic and common view for Europe of exploration knowledge and reserves of Strategic Raw Materials in Europe and internationally. o Better understand the metallogeny and ore prospectivity of EU's primary and secondary CRM and STR resources on land and the marine environment. This will improve the knowledge base and thereby increase the potential for secure and sustainable supply and also an expected impact in the minerals markets. o Dissemination of an innovative approach for the better use of STR through the EU stakeholders' network. o Promotion of better mining practices by promoting recycling and reusing of old tailings reevaluated for strategic commodities.
• Technical solutions helping the market to enhance the exploration phase, making it more efficient and less invasive, and optimising the performance and cost of deposit exploration (e.g. re-evaluating old mines); o Promote innovative geophysical techniques developed in projects such as SmartExploration throughout European mineral projects of strategic raw materials to reduce exploration investments and increase scarce but high value commodities. o Increasing knowledge of Strategic and Critical Raw Materials by-products of old and ongoing mines. FRAME will focus WP 2 and WP 3 in looking for new markets for the studding commodities in order to bring awareness of new uses for those commodities.
• Innovative solutions for mineral exploration and development (e.g. KDD techniques, including Data Mining, of newly created Knowledge Bases such as EU-RMKB), helping business and other stakeholders to optimize their investment; o Modelling techniques and predictive mapping may be of high importance to develop decisions in exploration and further in exploitation will be tested in WP 4, WP 5 and WP 6 to increase exploration frontiers. o New analytical approaches may also open frontiers to new Strategic raw materials in known and unknown areas and Strategic commodities. o Develop new viable uses/markets for strategical raw materials such as lithium, passing from ceramic industry to energy industry. • Data and tools to facilitate the re-use and recycling of mineral-based waste; o WP 7 tasks and achievements will contribute to better understanding of the metallogeny and ore prospectivity of EUs secondary CRMs resources on land in previously worked areas. This will improve the CRM knowledge base and thereby increase the potential for secure and sustainable supply indigenous to the EU. o This will make a key action concerning the improvement of the pan-European critical minerals deposit and mineral-based waste database,

ensuring that all available European data are current and have been checked for quality and accuracy at the national level, and to make them accessible in a seamless way to all users helping business and other stakeholders to optimize their investment.
• Reduction of the import dependency of Europe's industries for critical raw materials
o WP 4, WP 5 and WP 6 will extend reserves throughout an exploration effort of commodities such as phosphates, lithium, graphite, cobalt, niobium and tantalum in with the aim to reducing dependence from outside countries.

Evaluation of deliverables

No.	Title	Status (Approve/ Reject)
D1.4	Management report (submission of consolidated report to the European Commission)	Approve
D1.5	Management report (submission of consolidated report to the European Commission)	Approve
D1.6	Final Report	Approve
D2.5	Triannual newsletters	Approve
D2.6	Final newsletter	Approve
D3.2	Providing a data platform, digital version of metallogenic map and related description report highlighting the endowment and exploration potential of CRM in Europe	Approve
D3.3	Producing a predictivity map outlining the CRM exploration potential areas and the major prospective minerals belts	Approve
D3.4	Providing CRM data and intelligence to EURMKB (RM1) and the GeoERA information platform	Approve
D3.5	Prospectivity maps of CRM in Europe	Approve
D4.2	New mineralogical and geochemical data on samples from phosphate deposits/occurrences (+ host black shales). These samples should be as numerous and as widely geographically distributed as possible, and coming from different types of deposits	Approve
D4.3	Detailed metallogenic studies of key phosphate deposits. The selection of deposits aims to be as representative as possible of the phosphate deposits encountered in Europe	Approve
D4.4	Development of a procedure to prepare and analyse phosphate deposits with the objective to provide internally consistent geochemical data at a European level for this type of mineralization	Approve
D4.5	Providing Phosphate data and intelligence to EURMKB (RM1) and the GeoERA information platform	Approve
D5.1	Provide mineral potential and prospectivity maps of key mineral provinces in Europe with deposits of, or potential for, energy	Approve

	critical elements (natural graphite, lithium, cobalt) in collaboration with WP 3	
D5.2	Develop and/or review models for the formation of natural graphite, lithium and cobalt in Europe	Approve
D5.3	Report: Energy critical metals and minerals in Europe; occurrence, types, characteristics, formation, and future potential for European production	Approve
D5.4	Map of Cobalt, Graphite, Lithium deposits (including deposits where cobalt is a significant byproduct)	Approve
D5.5	Relevant Metallogenic maps	Approve
D5.6	Provide INSPIRE-compliant harmonised data on deposits and prospects of natural graphite, lithium and cobalt for the EURMKB (RM1)	Approve
D6.1	A report on the distribution and systematics of Nb-Ta mineralisations in Europe, including a case study. This will include new INSPIRE compliant data of selected Nb-Ta deposits that will be available for integration into the EURMKB (RM1) and the GeoERA Information Platform	Approve
D6.2	A report outlining recommendations for future exploration in Europe for Nb-Ta	Approve
D6.3	A discussion and draft outlining the possibilities for relieving European import dependence and improvement of conditions for Nb-Ta production in central Africa	Approve
D6.4	Providing Nb-Ta mineralisations in Europe data and intelligence to EURMKB (RM1) and the GeoERA information platform	Approve
D7.3	Report 2: Case studies	Approve
D7.4	Report 3: Final Report	Approve
D7.5	Site info in raw materials data bank and GeoERA IP	Approve
D8.2	Implement IT equipment infrastructure capable of interacting with internal system requirements to ensure delivery and increase the reliability of data and information to the EURMKB	Approve
D8.3	Assist in the data planning for the raw materials under study	
D8.4	Final compilation of data and delivery to central GeoERA IP	

Has the quality as a whole been achieved according to the objectives? Has the project as a whole been making satisfactory progress?

☐ 5 - **Overachiever** (the project has achieved all objectives and goals for the period and has even exceeded expectations)
☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals for the period)
☐ 3 - **Good progress** (the project has achieved most of its objectives and goals for the period with relatively minor deviations)
☐ 2 - **Acceptable progress** (the project has achieved some of its objectives)
☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives)

Comments (highlighting the project progress) / deviations / recommendations:

The project was managed excellently, and it fully achieved all objectives and goals.

Unfortunately, due to the COVID-19 pandemic execution of some of the planned tasks had to be modified (e.g., WP7), which the project team carried out very successfully.

It has been recognized that harmonization and verification of data was a big challenge. Standardizing methods for data collection and data entry on an EU level is therefore crucial. It is advised to also include other types of geological information (e.g., geophysical data obtained by satellite systems).

It is recommended to continue the research on potential targets areas (which have been identified within this project), on revisiting old mining sites which have the potential of still containing any CRM, and overall to continue the work on expanding the knowledge regarding critical raw materials resources in Europe.

3 LEVEL 3 – REVIEW OF THE THEME PROGRESS

In this section the project is reviewed ”remotely” on the basis of the respective reports. This part is filled in by Theme coordinator with aim to review the achieved scientific goals in accordance with theme objectives, on the basis of Sheet 3 in MPPR / FPPR – Project contribution to GeoERA project.

Project contribution to GeoERA project (from MPPR / FPPR, sheet 3):

FRAME is one of the cornerstones of the GeoERA Raw Materials theme. This project handles the Critical Raw Materials in a follow up of the EU Commission’s constant concerns regarding the sustainable sourcing of crucial raw materials to industrialised Europe, the contribution to the Circular Economy (reducing waste and using secondary raw materials), the Battery Alliance and the Decarbonisation of the economy.
FRAME is conceived beyond the scope of the time frame of the project. Hence, it focuses equally on a new EU law out on the 1st of January 2021 – the Conflict Minerals Regulation, which aims to help stem the trade in four minerals – tin, tantalum, tungsten and gold (3TG) - which sometimes finance armed conflict or are mined using forced labour.
This overall philosophy of research in FRAME fulfils the main objective of GeoERA, which is to contribute to the optimal use and management of the subsurface. GeoERA that will aim to support 1) a more integrated and efficient management and 2) more responsible and publicly accepted, exploitation and use of the subsurface.

Theme objectives:

GeoERA RawMaterials Theme objectives are defined by the Grant Societal Challenges acknowledged by the European Union and the UN SDG. They are descript on a topic-specific basis in the Raw Materials Initiative and policies derived from it (i.e. COM(2008) 699 final; COM(2011) 25 final), in particular:

- the security and sustainability of mineral raw materials supply from EU domestic sources and other sources (primary and secondary) and
- the management of competing uses of the European surface and subsurface.

The overarching goal “*Improvement of EU raw material resilience*” is key to all GeoERA RawMaterials projects, whilst the scientific projects are focusing on specific facets of the challenge. All four scientific projects of GeoERA RawMaterials worked closely together to achieve the overall goals and to meet the needs of the stakeholders as much as possible under the given conditions. They provide fundamental knowledge and information specifically responding to the demands and challenges addressed by the EC, while the goal “*Updating contributions to and*

augmenting the coverage of the Annual Minerals Yearbook published by the Minerals4EU project“ was an objective of MINTELL4EU very much supported by all GeoERA RawMaterials Projects. Through FRAME and their expert network information and data compiled in MINTELL4EU are cross checked for validation and completeness to the level possible.

The EC gives focus to the Critical Raw Materials for Europe (CRM) which are key also to FRAME. However, with “Forecasting and Assessing Europe’s Strategic Raw Materials needs” also known as FRAME the wider approach considers the high importance of mineral raw materials for our society and takes a strategic look beyond the actual list of critical raw materials to the EU. With this approach FRAME was able to respond to urged requirements expressed by the European Commission.

FRAME responds to the predefined main goals of GeoERA RM “*Extending, deepening, upgrading the quality of the pan-European primary and secondary continental and marine resources inventory*” through new data and information, new technologies and guidance for improved analytical procedures for example. The close cooperation with MINDeSEA allowed to link the information on CRM to those of the landlocked CRM for the first time in Europe.

The goal of “*Performing pilot studies supporting exploration and development of mineral raw materials*” is targeted by various case studies, including those that looked into the potential for CRM provided by heaps and tailings of historical mining sites. Albeit the shortfalls in fieldwork and laboratory work caused by restrictions of the pandemic FRAME provides information of if, when and where the remains of historical mining sites may be add to Europe’s raw material stock. Also the wok on analytics (i.e. phosphorites) is an important steppingstone towards a common understanding and database required for further exploration and exploitation of raw materials.

The goal “*Implementation of innovative and efficient approaches throughout the mineral raw materials value chain, with the aim of optimizing the use and management of the resources, while minimizing negative environmental, health and societal impacts*” is addressed and responded from the angle of sustainability and due diligence as well as from the angle of likelihood of success. Outlining prosperity and probability maps are an innovation for the majority European public authorities that has the potential to further unlock Europe’s raw materials potential and might assist when earmarking public and investors’ money. Hence, the results and recommendations compiled assist the challenges of the very Member State to safeguard areas and to manage the geological space in their territory.

FRAME has fully meet the designated objectives of GeoERA RawMaterials and those defined within the project.

Has the project as a whole achieved the objectives and expected impact of the theme?

☐ 5 - **Overachiever** (the project has achieved greater impact on project theme and/or other themes than expected)

☒ 4 - **Excellent progress** (the project has fully achieved its objectives and goals towards the theme as expected)

☐ 3 - **Good progress** (the project has achieved most of its impact towards the theme for the period with relatively minor deviations)

☐ 2 - **Acceptable progress** (the project has minor impact)

☐ 1 - **Unsatisfactory progress** (the project has failed to achieve critical objectives and/or has no impact on the theme)

Comments / deviations / recommendations:

Right from the beginning FRAME has worked under close attention of the European Commission that asked for easy accessible and up-to date reliable raw materials data. FRAME made big efforts to successfully respond to ad-hoc requirements of the European Commission already at the first half of project period. The outlook of Europe´s raw material potential is an important – first – step towards it resilience. With FRAME and the related GeoERA Projects the national/regional Geological Surveys can highlight areas of significant potential with prospectivity modeling as an innovation on its own.

Yet, those information are a snapshot in time. Taking and new information and developments into account (e.g. technological and analytical developments, societal requirements) forecast and assessment of our societies raw materials needs is a permanent task that should be sustained.

FRAME has shown that analytical techniques are also an essential part of developing targeted solutions. For this, further work is needed to provide reliable standards and reference materials. This work should be carried out by the respective geological services together with the relevant institutions.

The close exchange of information with MINDeSEA and MINTELL4EU and the consultation of MREG has been a great asset, leading to a significant improvement of the data in terms of quality and quantity and the most reliable and up-to-date freely available (greenfield) mineral information database in Europe. The great support if GIP-P has contributed to a usefull visualisation of the maps.
FRAME has made excellent progress in conjunjtion with the other Theme projects and GIP-P that should be sustained and further.

4 LEVEL 4 – GEOERA PROGRESS EVALUATION

In this section the project is reviewed on the Review meetings, where projects present their overall progress and achievements. This section relates to particular project, broader impact of GeoERA as a whole on policies will be covered at the Final Review meeting with questionnaire and interview with Evaluator.

Based on technical review summaries provided by Sections 1 – 3 of this report, and project presentation on the (Final) Review meeting:

Has the project as a whole been making satisfactory progress according to your own understanding and expectations of the GeoERA project?

☐ 5 - **Overachiever** (the project has exceeded expectations)
☒ 4 - **Excellent progress** (as expected)
☐ 3 - **Good progress** (minor recommendations given below)
☐ 2 - **Acceptable progress** (below expectations)
☐ 1 - **Unsatisfactory progress** (the project did not meet expectations)

Overall comments for the project (overall recommendations, modifications, corrective actions, or re-tuning the objectives to optimize the impact or keep up with the State of the Art, re-focusing, or a simple praise)

Stakeholder one review:

The GeoERA project builds successfully and impressively on former EU co-funded projects such as GEIXS and Minerals4EU to make publicly available geodata more easily accessible to stakeholders through map and database interfaces. A principal purpose is to help meet one of Europe's grand challenges which is to produce the minerals, especially but not limited to defined critical minerals, necessary to serve the future net carbon zero economies. At present, Europe in general is not seen by the global exploration and mining sector as a particularly mining friendly territory and only Finland ranks, at number 10, in a recent study carried out by the Fraser Institute's survey of mining companies' mining investment attractiveness index 2020. Put another way, the people of Europe need minerals but they are not perceived to welcome mining, with the result that exploration and mining companies and, importantly the investors, shareholders and pension fund managers who fund the industry, tend to look elsewhere. It is therefore necessary to improve the attractiveness of mining in Europe in every way possible, and the GeoERA project contributes admirably towards this objective.

One of the inhibitors to developing the European mining industry, and other sectors that depend on good access to geodata, is the difficulty in obtaining such information, partly as a result of the fragmented way in which geodata are managed (27 national geological surveys in the EU alone plus sub-national institutions, each with their own protocols and formats, with further important datasets held in universities and other academic institutions). It is therefore necessary to make available quickly and easily the necessary geodata, suitably harmonised and up to date, that make investing in European mining projects more attractive on a risk-reward basis. It is a huge undertaking and GeoERA makes significant progress towards this aim. The project is enhanced by its attention to conflict minerals, so as to inform policy makers and investors how best to comply with developing international legislation and good ethical behaviour, and historical mining which in the right circumstances could be attractive targets for new work.

GeoERA has, without doubt, produced outstanding results. The user interface works well and the geodata are valuable and well presented. The project members are to be congratulated for these achievements especially so in the light of restrictions imposed by the Covid pandemic. The data now available to stakeholders represents a state-of-the-art snapshot of what is available. Ultimately the quality, suitability and maintenance of the data are the responsibility of their custodians, for which GeoERA can have had only limited influence. However, the project has made great progress in harmonisation and quality control, wherever possible.

The project deliverables form the foundation for much further work. It is suggested that to be useful to the mining industry as well as policy makers and public opinion it will be necessary to:-

a) Add further data layers including geophysics, ground and satellite derived geochemistry, land use (such as national park areas), cadastral information (licence availability etc), cultural information (such as infrastructures, road and rail networks), legislative / tax and environmental controls. This will be a multi-disciplinary, complex and sensitive task, but should not be overlooked because of its difficulty. Prospective geology is necessary but not sufficient to attract mining; other factors prevail. There are also non-mining uses of the geodata, such as in engineering and environmental projects, in which decision making is based on multiple factors including, but not limited to, the geodata themselves.
b) Generate post-project sustainability in order to maintain and add new data. This is a challenge to the structure of defined time EU projects and institutions which move on to something new at the end of each project, and

its funding. Nevertheless, a way must be found to continue to support and build on the achievements made in this project, by identifying baseline funding either from a public sector source of by spinning out the project into a profit making private enterprise, possibly using EU supplied seed funding to take a commercial stake in such a company. A minor criticism of the project is that insufficient attention has been given to its long term exploitation and the dissemination has tended to be from scientist to scientist rather than from scientist to industry / policy makers / the public.

In summary, this is an impressive piece of work that moves towards meeting important national and trans-national goals but which must now be built on and developed in imaginative ways. It is hoped that the European Commission will show vision and flexibility so to do, in partnership with the public bodies such as the European geological surveys but also with the global mining sector, the investors therein, and the various other stakeholders such as environmental groups.

Stakeholder two review:

The very comprehensive FRAME project has achieved impressive results.

Its merits are that it provides a data platform with a digital metallogenic map highlighting the endowment and exploration potential of CRM in Europe. It produced both a predictivity and a prospectivity map outlining the CRM exploration potential areas and major prospective mineral belts, and providing CRM data and knowledge to EURMKB and the publicly accessible GeoERA information platform.

The extensive FRAME project included new data into existing databases, geochemical data was harmonised, prospectivity mapping took place, and the results were well communicated by reports map and publications. The innovative aspect is that Pan-European metallogenic maps were compiled for the various areas, unlocking old data which has not been looked at before.

Fact sheets and profiles of deposits as well as the activity status of operating mines round the dataset off. There might be still space for a survey of the reserve situation of commodities, such as ranges of reserves, life of mines, etc. which should be considered, insofar as they have not already been taken into account. The data forms a modern raw material database for state geological surveys, academic and research institutions, and will trigger research and exploration activities by companies.

A wise choice of special deposit types aims to meet current needs of Europe's economies, such as food and energy supply and CRMs for the European high technology industries. Examples are new mineralogical and geochemical data and metallogenic studies on phosphate deposits/occurrences, as well as mineral potential

and prospectivity maps of deposits of energy critical elements in Europe for future European battery raw material production. Furthermore, data was provided on the distribution and systematics of Nb-Ta mineralisation and future exploration targets in Europe to EURMKB and the GeoERA information platform. Deposit occurrence, characteristics and formation data were provided in an INSPIRE-compliant harmonised dataset, standardised and comparable.

The FRAME project not only combines different CRM data of different projects, but also assesses, evaluates and interprets it in terms of genesis and prospectivity. Evaluation of the prospective areas and deposits according to an evaluation matrix have yet to be defined. The interactive map is a tool that will certainly be very useful to all. The possibilities of using AI for harvesting of non-harmonized data should be investigated in order to focus the research agenda.

The project management has performed well and the collaboration between the partners was effective. The deliverables have been submitted and completed, and the milestones have been achieved in time. Project results and information were disseminated adequately and project partners have interacted excellently with other GeoERA projects and international bodies.

A positive outcome is that the European mining industry, consultants and project developers have partly been informed about this new Pan-European dataset by dissemination activities, starting with FRAME having been at PDAC in 2020, where industry was certainly reached. However, any feedback from industry about the initiative during the professional events should be reported.

It is recommended that the project, its achievements and opportunities are communicated to political decision makers, especially to economic ministries, regional planning and environment, in order to facilitate the realization of sustainable and environmentally conscious mining projects for CRM commodities in Europe.

Possible extensions of the project could be the integration of geophysical datasets and of new exploration method data into the mineral potential maps in order to facilitate exploration of deposits under cover. Similarly, the possibility of merging uncovered geological maps with mineral occurrence maps and structural datasets should be created.

An important work package achievement is investigation of the classical European mining districts for CRM by-products using new, complex assessments of the viability and processability taking into account the current state of scientific and technical knowledge. There is potential for more studies of that kind.

Overall, the very successful project forms a *fantastic foundation layer for further development*, with a lot of data usage potential.

Annex 1: Review meeting list of participants

Name	Role	Organisation
Joop Hasselman	GeoERA coordinator	Netherlands Organisation for Applied Scientific Research
Christoph Gauert	GeoERA Stakeholder	State Office for Geology and Mining Saxony-Anhalt
David Ovadia	GeoERA Stakeholder	Exploration and Mining company
Barbara Simić	Monitoring and Reporting Officer	Geological Survey of Slovenia
Aleksandra Trenchovska	Monitoring and Reporting Officer	Geological Survey of Slovenia
Jasna Šinigoj	Scientific Officer	Geological Survey of Slovenia
Emil Pučko	Scientific Officer	Geological Survey of Slovenia
Matija Krivic	Scientific Officer	Geological Survey of Slovenia
Antje Wittenberg	Raw Materials Theme Coordinator	Federal Institute for Geosciences and Natural Resources, Germany
Daniel de Olivera	Project manager	The National Laboratory of Energy and Geology, Portugal
Teresa Calabaca	Project member and WP2 lead	The National Laboratory of Energy and Geology, Portugal
Martiya Sadeghi	Project member and WP3 lead	Geological Survey of Sweden
Sophie Decrée	Project member and WP4 lead	Geological Survey of Belgium
Havard Gautneb	Project member and WP5 lead	Geological Survey of Norway
Helge Reginiussen	Project member and WP6 lead	Geological Survey of Sweden
Henrike Sievers	Project member and WP7 lead	Federal Institute for Geosciences and Natural Resources, Germany

Lidia Quental	Project member and WP8 lead	The National Laboratory of Energy and Geology, Portugal
Eric Gloaguen	Project member	The French Geological Survey