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Application of UNFC-2009 to phosphate rock - uranium resources: A case study of the El-Sebaeya Projects, Nile Valley, Egypt

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Summary

This document provides a case study that looks at the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) to uranium resources in phosphate rock in the El-Sebaeya Projects located in the Nile Valley, Egypt. Phosphate rocks are important sources of plant nutrients and represent one of the most significant sources of unconventional uranium resources in the world. The East and West El-Sebaeya Projects of the Nile Valley are some of the most important sources of phosphate rock in Egypt. The quantity of phosphate rock estimated in these projects is 2.1 billion tonnes and the uranium about 107,000 tonnes. According to UNFC-2009, the phosphate rocks are classified as Commercial Project and Potentially Commercial Project and the contained uranium separately as Potentially Commercial Project. Phosphate rock production is ongoing in these projects and a major phosphoric acid and fertilizer industry complex is planned. Uranium extraction as a co-product could be possible along with fertilizer production. The projects will hence provide a major contribution to the food and energy security of Egypt, as well as the region. The purpose of this case study is to demonstrate the application of UNFC-2009 in classifying and reporting quantities in a multiple commodity project such as the Nile Valley Project, where phosphate and uranium could be produced as co-products.

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I. Introduction

1. This case study was prepared by Mr. Mohamed Montaser of the Nuclear Materials Authority, Egypt, with the technical input of Mr. Harikrishnan Tulsidas of the International Atomic Energy Agency (IAEA).

2. The world is facing an unprecedented energy challenge. Global energy demand is projected to rise by over 50 per cent by 2040 [1]. The urgent need to reduce greenhouse gas emissions will require that much of this growth is supplied by low-carbon energy sources. Independent global institutions are agreed that it will be very difficult to achieve this without significantly increased deployment of nuclear energy. The Intergovernmental Panel on Climate Change (IPCC) stresses the urgency on the need to use all available low-carbon technologies to avert climate change. Nuclear energy and renewable energy are the key elements of a low-carbon energy system, along with carbon capture and storage (CCS) [2]. The International Energy Agency (IEA) and the Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) have projected that nuclear capacity will need to double by 2050 [3]. In tandem with the anticipated growth in nuclear energy, uranium requirements will also increase sharply in the future [4]. This will require looking at all available options for the supply of uranium – both conventional and unconventional resources.

3. Uranium resources are broadly classified as either conventional or unconventional. Whether uranium can be designated as conventional or unconventional is based mainly on the economics of its recovery from a given mining/extraction project. Conventional resources are those that have an established history of production where uranium is a primary product, co-product or an important by-product (e.g. from the mining of copper and gold). Very low-grade resources or those from which uranium is only recoverable as a minor by-product are considered unconventional resources [4]. In general, unconventional are resources that are of low to very low grade (10–200 parts per million (ppm) of uranium (U) on average) that cannot be mined just for uranium.

4. Uranium recovery from unconventional resources will need to take into account economic factors, such as cost of production and the trends in the primary uranium market. In some cases, it could be part of large-scale operations where economies of scale partly compensate for the ore's low grade. The most abundant unconventional uranium resources are seawater and phosphate rock deposits [5, 6, 7].

5. In October 2007, the President of Egypt announced the decision to start a peaceful nuclear programme and build a number of nuclear reactors to diversify and secure energy resources. Based on this decision, the Nuclear Materials Authority of Egypt also started to re-evaluate Egypt's uranium resources. To date, the most significant uranium resources in Egypt are those resources that are associated with phosphate rocks.

II. Uranium extraction from phosphate rock

6. Energy, food and water security, as well as environment, safety and health are critical challenges for sustainable development in the twenty-first century; therefore, recovering uranium as a co-product from phosphoric acid presents a particularly interesting case, with multiple pointers to sustainability issues [8].

7. Phosphate rocks represent one of the most important unconventional uranium resources in the world. The uranium content of phosphate rock can vary from 20 ppm to as high as 500 ppm. Several studies have reported that the average uranium concentration is generally close to 100 ppm in most phosphate rocks. In April 2015, the International Atomic Energy Agency (IAEA) World Distribution of Uranium Deposits (UDEPO)

estimated there were 13.8 million tonnes (Mt) of uranium in phosphate rock deposits [9]. Phosphate deposits are classified into two main categories: igneous phosphate rocks (13 per cent) as found in Russia, South Africa, Brazil and sedimentary phosphate rocks (87 per cent) as found in Morocco, Algeria, Jordan, Egypt, and the United States of America [10]. The phosphate minerals in both types of ore are of the apatite group, of which the most commonly encountered variants are fluorapatite and francolite.

8. In wet chemical phosphate fertilizer production, phosphoric acid is an intermediate product. During the process, about 80–90 per cent of the uranium contained in the phosphate rock migrates to phosphoric acid. The uranium concentration in wet phosphoric acid can vary from 30 to 350 mg/L depending on the original concentration of uranium in the phosphate rocks [11, 12]. Global phosphoric acid demand is forecast to grow at an annual rate of 2.4 per cent compared with 2014, rising to 48.3 Mt P_2O_5 in 2019. Potential global phosphoric acid supply/demand conditions show balance in the short term and a moderately growing surplus in late 2018 to early 2019. Close to 30 new units for processed phosphates are planned between 2014 and 2019. Together, China and Morocco will account for half of these plants. Other plants will be built in Saudi Arabia, Brazil and India [13].

9. Uranium can be recovered from phosphoric acid by several techniques such as precipitation [14], liquid membranes [15], solvent extraction [16] and solid impregnated solids [17]. However, solvent extraction which was widely practiced during the 1970s and 1980s is the only large-scale commercially proven method. Currently, about 72 per cent of the phosphate rock produced globally is used to produce phosphoric acid by the wet process and uranium recovery from phosphate rock is 83.7 per cent [18]. Generally, uranium recovery from dihydrate phosphoric acid through use of solvent extraction is a well-established technology [11].

10. Despite the accident at the Fukushima Daiichi Nuclear Power Plant in Japan in March 2011, nuclear energy is still expected to play an import role in the future energy mix. To sustain nuclear power under the current state of nuclear power plant technology, it will be necessary to prospect unconventional resources because primary resources of uranium are limited [19]. Among the unconventional resources, phosphate rocks attract a great deal of attention. If properly implemented uranium recovery from the current production of phosphoric acid could provide up to 20 per cent of the annual world uranium consumption [20].

11. Due to falling uranium prices, by the mid-1990s operations became uneconomic and all production from phosphoric acid ceased. The price of uranium increased from around US $10/lb U_3O_8 (US $26/kg U), through to a peak of US $138/lb U_3O_8 (US $359/kg U) in June 2007, to current long term and spot prices of approximately US $45/lb U_3O_8 (US $117/kg U) and US $35/lb U_3O_8 (US $91/kg U) respectively. Uranium recovery from phosphoric acid has many advantages, including: (a) industrially proven in numerous plants (b) no mining costs, (c) easy to permit, (d) saving a resource otherwise lost forever, (e) other elements of value (such as thorium and rare earth elements (REE)) can be recovered from the same liquid [21]. Uranium recovery from phosphoric acid though faces several challenges, for example: (a) fluctuating uranium prices, (b) unfavourable public perception and political support (e.g. due to the accident at the Fukushima Daiichi Nuclear Power Plant in Japan), (c) industry fatigue to innovations, and (d) industry becoming more risk averse.

III. Phosphate resources of Egypt

12. Phosphate deposits in Egypt are part of the Middle East to the North African Phosphogenic Province of the Late Cretaceous-Palaeogene age. The occurrences are divided into three east-west trending facies belts (Figure 1) [22]:

(a) Phosphorite of the northern facies belt which has no economic potential, spreading from Bahariya Oasis to Sinai as thin layers mainly of carbonate and sand facies.

(b) Phosphorite of the central facies belt represents the most economic occurrences and is confined to the following localities:

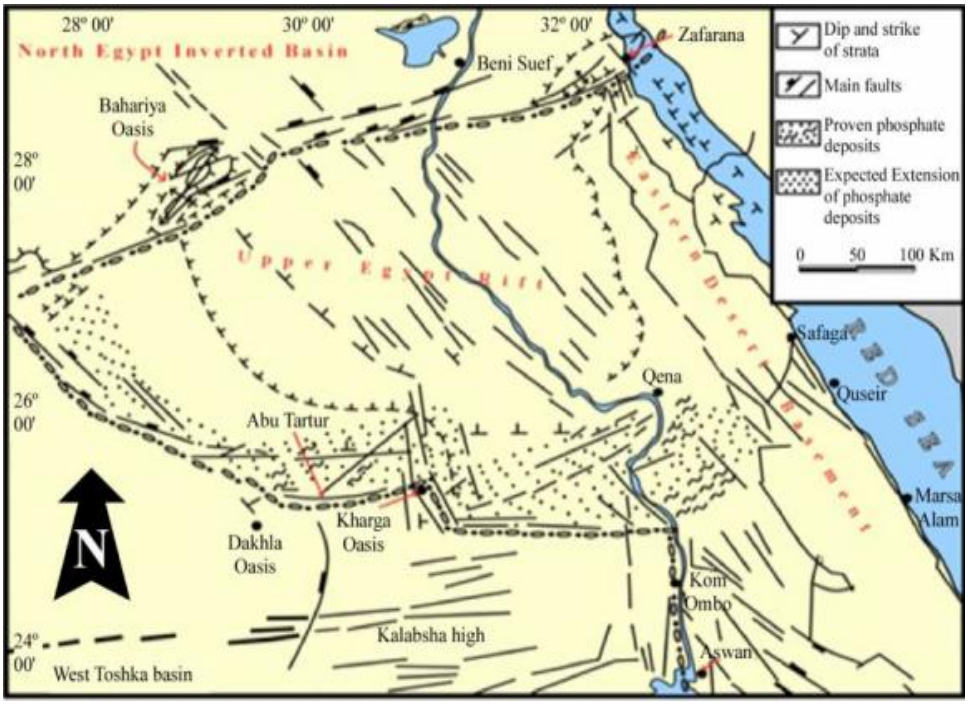
(i) The Red Sea Coast from Safaga to the Quseir land-stretch

(ii) The Nile Valley between Idfu and Qena

(iii) The Western Desert on the Abu Tartur Plateau (New Valley area).

(c) Phosphorite of the southern facies belt. The rocks of these facies are associated with iron ore accumulations among shallow water sediments.

Figure 1
Distribution of phosphate deposits in Egypt

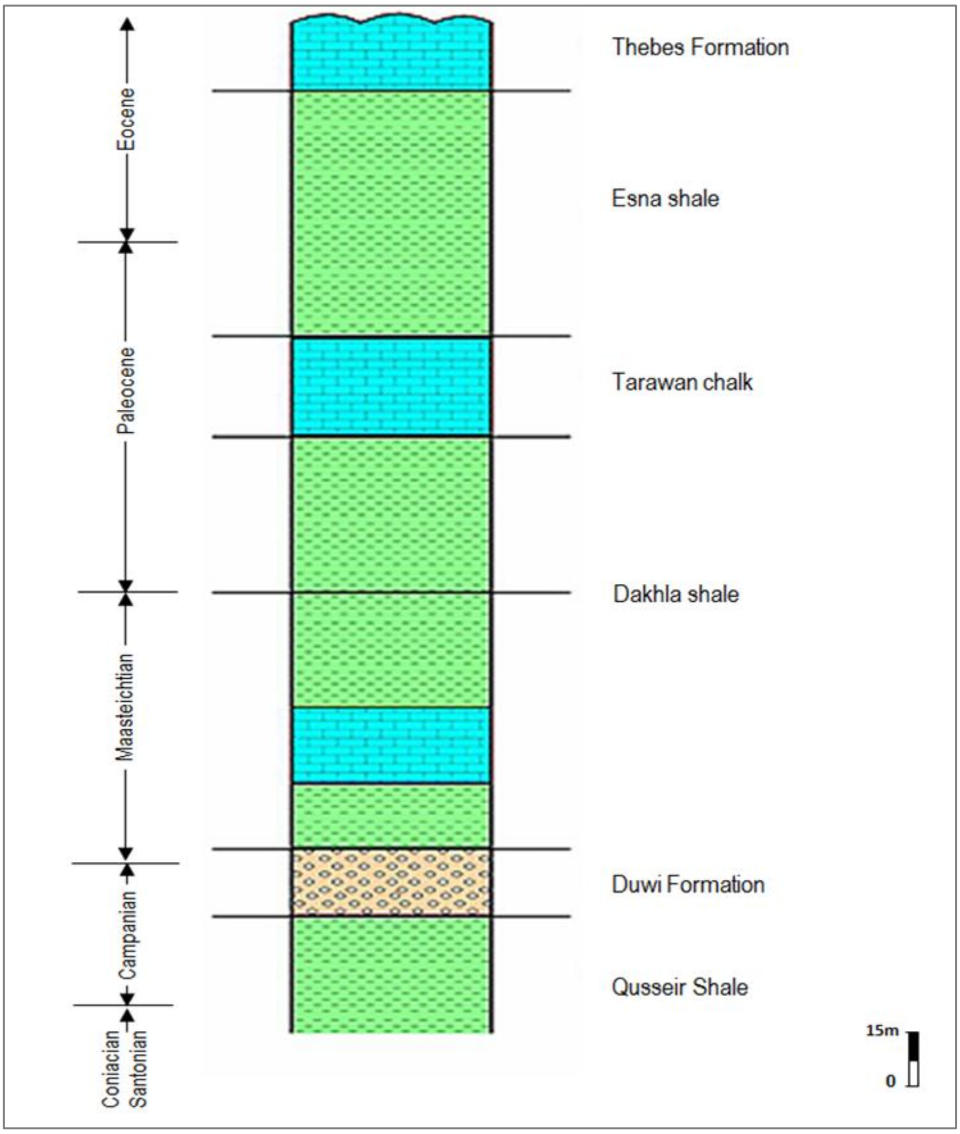


13. Francolite is the main phosphate mineral of the Nile Valley deposit, while fluorapatite is the principal phosphate mineral in the New Valley deposit [23].

IV. Nile Valley phosphate deposits

14. The Nile Valley phosphate deposits extend between latitudes 25^{o} 30^{-} – 26^{o} 30^{-} and longitudes 32^{o} 30^{-} – 33^{o} 30^{-} on both sides of the Nile Valley [24]. Several attempts were made to classify the Upper Cretaceous-Lower Eocene succession in the Nile Valley region. The general sedimentary sequence in the Nile Valley region was classified into the formations shown in Figure 2 (from bottom to top) [25].

Figure 2
Generalized stratigraphic section in the Nile Valley region



15. The Duwi Formation in the Nile Valley region was divided into three members (from bottom to top):

(a) Mahamid Member: Composed of shale, clay, sandstone, carbonaceous shale with a few phosphatic intercalations.

(b) Sibaiya Member: Made up of siliceous-carbonate phosphorite beds intercalated with chert bands and lenses changing upwardly to shale, oyster limestone and marl.

(c) Adayma Member: Consists of marl, sandstone, and some oyster limestone and phosphate beds.

16. The lower part of the Duwi Formation (Mahamid Member) was assigned as the Campanian age. The Middle part was also considered as Maestrichtian age and as Campanian-Maestrichtian age. The Upper Adayma Phosphate Member has a Danian age and a Maestrichtian age [26]. The Duwi Formation in the Nile Valley region was subdivided into three members based on its lithology [27]:

(a) The lower member is composed of quartzose sandstone and siliceous shale.

(b) The middle member is built up of soft, laminated and organic-rich black shale.

(c) The upper member is mainly made up of phosphatic sandstone.

17. *Chemical and Mineralogical Composition:* The chemical composition of the phosphate beds in the Idfu – Qena region varies according to the nature of its cementing material (Table 1). The phosphorite components are represented by phosphatic pellets and phosphatized organic remains with predominance of the former. The grain size ranges between 0.1–2 mm with the prevailing size varying between 0.2–0.4 mm. The phosphate material in the pellets is represented by collophane, 49–60 per cent of the rock, with subordinate amounts of finely dispersed organic material and pyrite specks [24].

18. In the biomorphic phosphatized bones and remains, aside from the phosphate material, there are considerable amounts of organic impurities. Among the non-phosphatic grains quartz (0.05–1 mm), pyrite, and more rarely carbonate rocks, are seen. The cementing material of the phosphorite grains consists of carbonates, clays and silica mixed together in different proportions and with impurities of dolomite and ferro-dolomite. Carbonate, clay and carbonate-clay cement are syngenetic, whereas the siliceous cement was formed during later diagenetic stages [24].

Table 1
Chemical composition (in %) of the El-Sebaeya phosphate deposit

Compound	*Carbonate Variety*	*Carbonate-Siliceous Variety*	*Clayey-Carbonate Variety*
P_2O_5	22.7	21.24	20.28
CaO_2	48.06	38.44	40.16
SiO_2	4.80	13.05	12.07
Al_2O_3	0.32	0.42	0.95
Fe_2O_3	0.94	1.03	1.50
MgO	0.32	0.44	0.86
SO_3	0.20	-----	----
CO_2	17.70	11.10	12.06
I.R.*	4.86	14.08	12.04

* I.R. – Insoluble Residue.

IV. Insoluble Residue

19. The carbonate variety of phosphorites characterizes the beds of the middle member and has a mineralogical composition which consists of phosphate mineral (52.0 per cent), calcite, (38.3 per cent), dolomite (1.4 per cent, quartz (4.2 per cent), clay (2.0 per cent),

gypsum (1.2 per cent) and limonite (1.0 per cent). The carbonate-siliceous and the siliceous-carbonate varieties are very common in beds of the middle member in the localities of Serai, El Gir and Mashash and they are in general the most widespread in the region. The carbonate-clayey and clayey-carbonate varieties of the ore usually dominate in beds of the upper group [24].

20. Among the phosphorites which fall within the weathering zone, those which are most affected by the chemical weathering produce leached types of deposits in which P_2O_5 is enriched to 25–28 per cent and, which is most economically favoured in the El Mahamid area. Generally, in the zone of weathering all types of cementing materials contain supergene minerals as limonite and gypsum. Recent tests for Nile Valley phosphate reflect the importance of limonite and gypsum in advanced fertilizer manufacturing and hence make them value added products which could be more attractive economically as opposed to exporting the phosphate rock [24].

21. *Mining and Processing:* Mining of phosphate ore at the Nile Valley locations of East and West El-Sebaeya is mostly by surface mining. The overburden is removed either by scraping or by drilling and blasting, depending on the nature of the rock. The phosphate bed is drilled, blasted, and removed by trucks to the crushing plant, where it is crushed to less than 5 cm and screened. The overburden thickness ranges between 20 to 40 metres [24].

22. At East El-Sebaeya, the phosphate ore used to be crushed and then attrition washed to remove the clayey fine fraction (about 10–12 per cent by weight, assaying about 12–18 per cent P_2O_5) and the hard siliceous coarse fraction (40–45 per cent by weight, assay 18–22 per cent P_2O_5). The ore is now being crushed and dry screened to remove the coarse siliceous fraction, and the marketable concentrate is the fine fraction (assaying 28–30 per cent P_2O_5). The control of air pollution under these circumstances is very challenging [24].

23. At West El-Sebaeya, there used to be a flotation plant where direct flotation and reverse flotation for upgrading the ore was carried out. However, for technical and economic reasons the flotation plant has been replaced by a crushing, screening, and de-sliming set up to remove the clayey fraction (about 20–25 per cent by weight, assaying 12–18 per cent P_2O_5), and the coarse fraction is rejected. Most of the production from this area is consumed locally for the production of phosphate fertilizers [24].

V. East and West El-Sebaeya Projects, Nile Valley: Classification of quantities using UNFC-2009

24. The United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) is a project-based system that applies to all fossil energy and mineral reserves and resources. It has been designed to meet, to the extent possible, the needs of applications pertaining to energy and mineral studies, resource management functions, corporate business process and financial reporting standards [28].

25. According to UNFC-2009 quantities are classified on the basis of the three fundamental criteria of economic and social viability (E), field project status and feasibility (F), and geological knowledge (G), using a numerical coding system. Combinations of these criteria create a three-dimensional system. The Categories and Cub-categories are the building blocks of the system, and are combined in the form of “Classes”.

26. *Assessment of phosphate rock quantities:* Quantities of phosphate rocks in the East and West El-Sebaeya projects of the Nile Valley are classified as Proved Reserves, Indicated Resources and Inferred Resources. There are about 49.0 Mt Proved Reserves of phosphate rock (34 Mt in the East El-Sebaeya Project and 15 Mt in the West El-Sebaeya Project). In addition, there are about 180 Mt Indicated Resources of phosphates in both the

El-Sebaeya Projects (80 Mt in the East El-Sebaeya Project and 100 Mt in the West El-Sebaeya Project. The Inferred phosphate Resource in the two El-Sebaeya Projects is about 2,384.0 Mt. Assuming an 80 per cent recovery for the Resources, a total of 2,100.2 Mt phosphate rocks are classified according to UNFC-2009 as G1, G2 and G3 quantities. About 512.8 Mt are considered as Additional Quantities in Place.

27. The EI-Nasr Mining Company has been mining phosphate rock from the El-Sebaeya Project for many years and in 2013, the production was approximately 3 Mt [24]. The quantities of phosphate rock mined are sold directly to the market. The quantities reported under the currently operating mine, estimated as Proved Reserves can be considered as F1.1, i.e., “extraction is currently taking place”. Estimated quantities of Indicated and Inferred Resources can be considered as F2.1, i.e., “Project activities are ongoing to justify development in the foreseeable future”.

28. The current economic and financial situation is expected to impact fertilizer demand in several ways. A return to more stable commodity prices makes it less risky for farmers to invest in fertilizers than one year ago; this is resulting in a more rapid recovery in phosphate (P) and potassium (K) fertilizer demand than had been foreseen. Supported by fairly attractive crop prices in the first half of 2014, world fertilizer consumption in 2014–15 increased by 2.0 per cent year-on-year, to 185 Mt plant nutrients (total $N+P_2O_5+K_2O$).

29. It is anticipated that phosphorous consumption will rebound to 41.3 Mt in 2014/15, which represents a 2.5 per cent year-on-year increase. Global phosphate rock supply is forecast to increase to 255 Mt in 2019, which is an increase of 16 per cent compared with 2014, [13]. This means that phosphate rock estimated as Proved Reserves in the El-Sebaeya projects can be assigned E1.1, i.e. “Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions”. Quantities estimated as Indicated and Inferred Resources can be assigned to E2, i.e. Extraction and sale is expected to become viable in the foreseeable future. Careful consideration of the E, F and G axes of UNFC-2009 was undertaken and these resources are designated as Commercial Project and Potentially Commercial Project as shown in Table 2.

30. ***Assessment of uranium quantities:*** Phosphate deposits are considered to be unconventional uranium resources i.e. uranium is recovered as a co- or by-product along with the main product, the phosphate. This means that the geological knowledge of uranium depends to a large extent on the geological knowledge of the phosphate deposits.

31. The EI Nasr Mining Company is currently mining and the current production is about 3 Mt of phosphate rocks per annum. All the current production is sold as phosphate rock. The company completed a feasibility study in 2010 for phosphoric acid production in cooperation with an Indian partner company and acquired the licences required to construct a phosphate fertilizer complex at the El-Sebaeya site.

32. Due to instability in the Egyptian markets resulting from the political situation in 2011, the EI Nasr Mining Company halted the construction activities of the phosphoric acid plant. At the beginning of 2015, the President of Egypt called for the construction of the phosphate complex at El-Sebaeya to re-start. The phosphate complex, which is expected to produce about 200,000 tonnes P_2O_5/year as phosphoric acid, should be completed by the end of 2017 with a capital cost of about US $400 million. Following the recent policy of maximum value-addition in Egypt before exporting raw material, it is anticipated that the capacity of phosphoric acid production may be progressively increased in future.

Table 2

Estimated phosphate rock quantities in East El-Sebaeya and West El-Sebaeya Projects, Nile Valley, Egypt
Effective date: 31 December 2013

Area	*Project*	*Average P_2O_5 Content, %*	*CRIRSCO Template*	*UNFC-2009 Class*	*UNFC-2009 Sub-class*	*UNFC-2009 Categories*			*Phosphate rock quantities (Mt)*	*Estimated Phosphate rock recoverable, Mt*
						E	F	G		
Nile Valley Deposit	East El-Sebaeya	29-30	Proved Reserves	Commercial Project	On Production	1.1	1.1	1	34.0	34.0
			Indicated Resources	Potentially Commercial Project	Development Pending	2	2.1	2	80.0	64.0
			Inferred Resources					3	1,674.0	1,339.2
			Additional Quantities in Place			3.3	4	1,2,3		**350.8**
	West El-Sebaeya	27	Proved Reserves	Commercial Project	On Production	1.1	1.1	1	15.0	15.0
			Indicated Resources	Potentially Commercial Project	Development Pending	2	2.1	2	100.0	80.0
			Inferred Resources					3	710.0	568.0
			Additional Quantities in Place			3.3	4	1,2,3		**162.0**
Total quantities (excluding Additional Quantities in Place)										**2,100.2**
Total quantities (including Additional Quantities in Place)										**2,613.0**

33. The average uranium content in the El-Sebaeya phosphate projects is about 90 ppm [24, 29–31]. It is assumed that about 70 per cent of this production could eventually be available for phosphoric acid production at the site. This assumption is based on the current global average of about 72 per cent phosphate rock being used in phosphoric acid production. It is also assumed that 90 per cent of the uranium present in the phosphate rock will report to phosphoric acid and the rest will remain in the phosphogypsum co-product. Finally, it is assumed that 90 per cent of the uranium can be extracted from the phosphoric acid using currently available technology. After applying all the above recovery factors, it is estimated that approximately **107,173.20** tonnes of uranium can eventually be recovered from the phosphate rocks. This uranium can be classified as G1, G2 and G3 based on the geological confidence determined for the phosphate rock (Table 3).

34. Field project status and feasibility of uranium recovery from phosphoric acid intimately depends on the feasibility of the phosphate deposit. Phosphate rock is used in phosphoric acid production and uranium can be extracted from phosphoric acid. Generally, in the wet acid process phosphate ore must have (i) P_2O_5 ≥30 % (ii) CaO/ P_2O_5 ratio <1.6 (iii) MgO <1 % and Fe_2O_3 and Al_2O_3 content maximum 2.5 %. Therefore the ores which do not fulfil these specifications cannot be used directly and require some beneficiation [32].

35. The scoping study for uranium recovery from El-Sebaeya phosphate rock uranium extraction is being developed. Plans are also in place to start a pre-feasibility study. Therefore, uranium quantities from the El-Sebaeya phosphate rock project are classified as F2.1 “Project activities are ongoing to justify development in the foreseeable future”.

36. The operational expenditure (OPEX) for uranium production by this process is expected to be around US $40-50/lb U_3O_8 (US $100/kgU), assuming that the costs estimated are as those for similar operations elsewhere in the world [33], which are close to the uranium long term and spot price in August 2015 (US $35 - 45/lb U_3O_8 or US $90- 117/kgU). This means that uranium recovery from El-Sebaeya phosphate rock can be considered E2 – “Extraction and sale is expected to become economically viable in the foreseeable future”.

37. In addition to the total quantities that could be recovered with currently proven technologies, about **127,996.80** tonnes of uranium will not be recovered and can be shown as Additional Quantities in Place. This is a significant amount of uranium. With the development of innovative technologies it could be possible to recover this uranium either partially or fully, thus improving the productivity and sustainability of the operations. The quantities of uranium available in the Nile Valley phosphate deposit are shown in Table 3.

VI. Summary and conclusions

38. The East and West El-Sebaeya Projects of the Nile Valley are some of the most important sources of phosphate rock in Egypt. The quantity of phosphate rock estimated in these projects is 2.1 billion tonnes. This is classified as Commercial Project and Potentially Commercial Project according to UNFC-2009. Phosphate rock production is ongoing in these projects and a major phosphoric acid and fertilizer industry complex is planned. The projects will hence provide a major contribution to the food security of Egypt, as well as the region.

Table 3

Uranium Resources in the East El-Sebaeya and West El-Sebaeya Projects, Nile Valley, Egypt
Effective date: 31 December 2015

Area	*Project*	*Average U Content, ppm*	*CRIRSCO Template*	*UNFC-2009 Class*	*UNFC-2009 Sub-class*	*UNFC-2009 Categories*			*Estimated recoverable U from Phosphoric Acid, (tU)*
						E	*F*	*G*	
Nile Valley Deposit	East El-Sebaeya	90	Measured Resources	Potentially Commercial Project	Development Pending	2	2.1	1	1,735.0
			Indicated Resources					2	3,265.9
			Inferred Resources					3	68,339.4
			Additional Quantities in Place			3.3	4	1,2,3	**87,579.7**
	West El-Sebaeya		Measured Resources	Potentially Commercial Project	Development Pending	2	2.1	1	765.5
			Indicated Resources					2	4,082.4
			Inferred Resources					3	28,985.0
			Additional Quantities in Place			3.3	4	1,2,3	**40,417.1**
Total quantities (excluding Additional Quantities in Place)									**107,173.2**
Total quantities (including Additional Quantities in Place)									**235,170.0**

39. Phosphate rock is one of the most important unconventional uranium resources. As uranium is recovered from phosphates as a co- or by-product classification of uranium according to UNFC-2009 is therefore related to the classification of the phosphate resources. The total quantity of uranium estimated for the Nile Valley Deposit is 107,173 tonnes of uranium, which is currently the most significant source of uranium in Egypt. Based on ongoing project activities such as the scoping study and the pre-feasibility study, this uranium can be classified as a Potentially Commercial Project. Moreover, 127,996 tonnes of uranium are estimated as Additional Quantities in Place, at least a part of which could be recovered by innovative techniques and improving the efficiency in mining and processing.

40. As Egypt has stated its intention to introduce nuclear energy systems in order to diversify the country's energy supply, the Nile Valley phosphate projects from which uranium can be produced as a co-product can be considered as the most advanced projects for commercial uranium supply in the country. In view that to date, no other conventional resource of uranium that can be classified as a Potentially Commercial Project has been identified in Egypt, the uranium in the Nile Valley is very significant for the energy security of Egypt.

41. The purpose of this case study is to demonstrate the application of UNFC-2009 in classifying and reporting quantities in a multiple commodity project such as the Nile Valley Project, where phosphate and uranium could be produced as co-products. Using UNFC-2009 for classification and reporting brings greater clarity to the reporting and demonstrates that phosphate and uranium projects are critical to the food and energy security of Egypt. This will vastly aid the management of natural resources and its timely development for the socio-economic development of Egypt.

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