The Status of the Front End of Saudi Arabia's Nuclear Cycle

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Summary and Main Arguments

In recent weeks, several articles have appeared regarding possible developments in the Kingdom of Saudi Arabia's (KSA) nuclear program. The *Wall Street Journal* published an article on August 4, 2020, reporting that "Western officials" believe a yellowcake facility (a uranium mill) had been constructed near the remote town of al-Ula in the country's northwest.[1] A few days later, the *New York Times* reported suspicions that a uranium conversion facility had been constructed at a site close to Riyadh.[2] Finally, on September 17, the *Guardian* published an article detailing the results of joint Chinese–Saudi prospecting effort of the country that identified a large quantity of uranium reserves.[3] Saudi Arabia has also constructed a facility, with Chinese assistance, to produce long-range solid-propellant ballistic missiles that could serve as a delivery system for a future nuclear force.[4]

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[1] Warren P. Strobel, Michael R. Gordon, and Felicia Schwartz, "Saudi Arabia, With China's Help, Expands Its Nuclear Program," *Wall Street Journal*, August 4, 2020, <https://www.wsj.com/articles/saudi-arabia-with-chinas-help-expands-its-nuclear-program-11596575671>.

[2] Mark Mazzetti, David E. Sanger, and William J. Broad, "U.S. Examines Whether Saudi Nuclear Program Could Lead to Bomb Effort," *New York Times*, August 5, 2020, <https://www.nytimes.com/2020/08/05/us/politics/us-examines-saudi-nuclear-program.html>.

[3] Emma Graham-Harrison, Stephanie Kirchgaessner, and Julian Borger, "Revealed: Saudi Arabia may have enough uranium ore to produce nuclear fuel," *Guardian*, September 17, 2020, <https://www.theguardian.com/world/2020/sep/17/revealed-saudi-arabia-may-have-enough-uranium-ore-to-produce-nuclear-fuel>.

[4] This facility was identified by colleagues at the James Martin Center for Nonproliferation Studies. See: Paul Sonne, "Can Saudi Arabia produce ballistic missiles? Satellite Imagery Raises Suspicions," *Washington Post*, January 23, 2019, <https://www.washingtonpost.com/world/national-security/can-saudi-arabia-produce-ballistic-missiles-satellite-imagery-raises-suspicions/2019/01/23/49e46d8c-1852-11e9-a804-c35766b9f234_story.html>; Phil Mattingly, Zachary Cohen, and Jeremy Herb, "US intel shows Saudi Arabia escalated its missile program with help from China," *CNN*, June 5, 2019, <https://www.cnn.com/2019/06/05/politics/us-intelligence-saudi-arabia-ballistic-missile-china/index.html>.

A research team at the James Martin Center for Nonproliferation Studies (CNS) analyzed each of these articles and has reviewed the underlying, unpublished reports. The purpose of this *Nonpro Note* is to capture the team's findings and analysis up to the date of publication. The research team did not observe current mining activities at the four most promising deposits identified by the Sino-Saudi prospecting project. The research team has been unable to substantiate the claims of the existence of a uranium mill at al-Ula. Further, the absence of identifiable uranium mining at any of the four sites rated as "very good" by the prospecting project casts doubt on the existence of a mill at al-Ula, which is also located some distance from all the uranium deposits. The research team has not been able to prove or disprove the allegation that a uranium conversion facility has been constructed near Riyadh, but several observations cast some doubt on the existence of such a facility in the described location.

Saudi Arabia has, in recent years, sought and found large quantities of uranium reserves. While KSA has detailed its civil nuclear plans, the country's leadership has also stated that they will pursue nuclear weapons if Iran does. Saudi actions can therefore be understood as a longer-term hedge against a nuclear-armed Iran. In this context, insufficient safeguards on KSA's nuclear program should be a point of concern for all countries. International nuclear suppliers and assistance providers, including China, should not provide further support to the budding Saudi nuclear program until Saudi Arabia has taken steps to demonstrate its peaceful nature, including rescinding its Small Quantities Protocol (SQP) and concluding an additional protocol with the International Atomic Energy Agency (IAEA).

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Context: Saudi Arabia's Nuclear Ambitions

The nature of the Kingdom of Saudi Arabia's (KSA) interests in nuclear technology has long been debated. In 1988, KSA acceded to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which requires states parties to conclude a safeguards agreement with the International Atomic Energy Agency (IAEA) within 18 months from accession. However, its comprehensive safeguards agreement (CSA) went into force only in 2009, and it has resisted more stringent safeguards that have become the international norm.[5] In March 2018, Crown Prince Mohammad bin Salman said that "Saudi Arabia does not want to acquire any nuclear bomb, but without a doubt if Iran developed a nuclear bomb, we will follow suit as soon as possible."[6]

Saudi Arabia's nuclear ambitions include substantial civil elements. In 2011, Saudi officials expressed the ambition to construct 16 nuclear power reactors over the next 20 years and have sought tenders from international reactor vendors for the construction of two reactors. The construction of a nuclear research reactor is almost complete.[7] Saudi officials also have expressed interest in acquiring front-end nuclear fuel-cycle capabilities, including mining, milling, conversion, enrichment, and fuel fabrication.[8] The plan calls for Saudi Arabia to develop a program that is linked to the international

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[5] The IAEA Board of Governors approved Saudi's CSA in 2005, but it only went into force in 2009 when "the Agency received from Saudi Arabia written notification that Saudi Arabia's statutory and constitutional requirements for entry into force had been met." See INFCIRC 746, February 16, 2009, <https://www.iaea.org/sites/default/files/publications/documents/infcircs/2009/infcirc746.pdf>. On Saudi Arabia's resistance to more stringent safeguards, see the Government Accountability Office, "U.S.-Saudi Nuclear Cooperation. Progress is Stalled over Nonproliferation Conditions and Agency Management of Negotiations Is Unclear," April 2020, <https://www.gao.gov/assets/710/705701.pdf>.

[6] CBS News, "Saudi crown prince: If Iran develops nuclear bomb, so will we," March 15, 2018, <https://www.cbsnews.com/news/saudi-crown-prince-mohammed-bin-salman-iran-nuclear-bomb-saudi-arabia/>.

[7] Geoff Brumfiel, "As Saudi Arabia Builds A Nuclear Reactor, Some Worry About Its Motives," *NPR*, May 6, 2019, <https://www.npr.org/2019/05/06/719590408/as-saudi-arabia-builds-a-nuclear-reactor-some-worry-about-its-motives>.

[8] K.A.CARE, "Our Projects," <https://www.energy.gov.sa/en/projects/Pages/default.aspx>.

nuclear fuel cycle, but is also indigenous. The Kingdom is charting a path toward oil export independence and likely does not wish to replace its dependency on oil for electricity production with a dependency on uranium imports. It is in this context that KSA has been investing in the front end of the nuclear fuel cycle, including training individuals in uranium mining and prospecting for uranium.[9]

Nuclear fuel-cycle independence raises particular concerns because these capabilities could be used for both weapons development and peaceful purposes. A country could conceivably indigenize the nuclear fuel cycle and then withdraw from the NPT, as North Korea did in 2003. Countries can also secretly pursue nuclear weapons while party to the NPT, as Iraq, Iran, Syria, and North Korea are believed to have done. To address the latter concern, the IAEA has developed enhanced safeguards provisions, particularly through the Model Additional Protocol.

Saudi Arabia's current safeguards are inadequate. KSA concluded a small quantities protocol (SQP) with the IAEA in 2005 that exempts the country from many of the inspection and reporting requirements provisions in IAEA Information Circular (INFCIRC) 153, the model for CSAs pursuant to the NPT.[10] In addition, KSA has not concluded an additional protocol (AP). As a result, the IAEA has limited insight into what nuclear activities are taking place in KSA.

This problem is compounded by a number of important but nuanced points around safeguards and export controls. The first is that, generally, CSAs alone do not cover the mining and milling of uranium, which are only partly addressed by APs. Full safeguards measures generally start midway through uranium conversion facilities. Second, because its SQP is based on an outdated model, Saudi Arabia is required to declare facilities to the

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[9] Arabnews, "KACARE launches uranium program to train Saudis," March 10, 2019, <https://www.arabnews.com/node/1464706/saudi-arabia>.
[10] IAEA, INFCIRC 153, June 1972, <https://www.iaea.org/sites/default/files/publications/documents/infcircs/1972/infcirc153.pdf>.

IAEA only when nuclear material is introduced to a facility, or when the quantity of nuclear material in the country exceeds certain defined thresholds.[11]

Based on its current safeguards obligations, Saudi Arabia is not required to report any uranium mining and milling activity. Also, Saudi Arabia could potentially construct fuel-cycle facilities, such as for conversion or enrichment, without declaring them to the IAEA until nuclear material is introduced into these facilities.The export of a conversion plant from any of the main nuclear suppliers to Saudi Arabia would trigger a requirement for the exporter to report the transfer to the IAEA under its AP.

Nothing suggests at present that KSA is in violation of its safeguards agreements. However, until Saudi Arabia recinds its SQP and ideally concludes an AP, its neighbors and the international community at large cannot be certain of the absence of such facilities in the country, or of KSA's intentions.

Examining the Allegations

In August 2020, the *Wall Street Journal* reported the alleged existence of a yellowcake (U^3O^8) factory near al-Ula, despite the Saudi Energy Ministry's categorical denial.[12] Shortly afterward, the *New York Times* reported on a suspected uranium-conversion facility near Riyadh.[13] In the course of examining these allegations, CNS received unpublished documents detailing the outcome of the joint China–KSA uranium-prospecting project. CNS also examined that the possibility that Saudi Arabia is already mining uranium.

It is not currently possible to conclusively validate—or dismiss—any of these allegations. It does not appear that KSA has commenced mining uranium at any of the

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[11] See IAEA, "Safeguards Implementation Guide for States with Small Quantities Protocols," <https://www-pub.iaea.org/MTCD/publications/PDF/svs22_web.pdf>, pp. 93 and 95.
[12] Strobel, Gordon, and Schwartz, "Saudi Arabia, With China's Help, Expands Its Nuclear Program."
[13] Mazzetti, Sanger, and Broad, "U.S. Examines Whether Saudi Nuclear Program Could Lead to Bomb Effort."

four sites identified as "very good" deposits by the joint Sino–Saudi project, which suggests that the construction of mills and conversion facilities would be premature. However, it is possible that KSA has a source of uranium other than the ones examined by CNS.

Prospecting

CNS received a number of unpublished technical reports on a uranium-prospecting project that ran from 2017–2019. This project was implemented jointly by Saudi agencies and a Chinese entity, the Beijing Research Institute of Uranium Geology (BRIUG). As a part of an effort to confirm the authenticity of these unpublished documents, CNS found a Chinese-language press release from November 2019 reporting on the visit of a Saudi Minister to BRIUG in China to discuss the results of uranium prospecting.[14] The results were described as successful.

The prospecting project was an intensive multi-phase effort that started with wide-area prospecting techniques validated through in-field activity. In some of these efforts, around a dozen candidate sites were identified. Four sites were singled out as being most promising. The inferred size of these deposits, which were classified in the report as "very good," was assessed as equal to more than 91,000 tons of U^3O^8.[15]

Mining

Primarily through the use of satellite imagery, CNS examined each of the four locations identified as "very good." At one site, ground imagery was used to discount the relevance of a nearby newly constructed building.

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[14] Beijing Research Institute of Uranium Geology, "沙特工业与矿产资源部副部长哈利德·穆戴菲一行来访我院," <http://www.briug.cn/index.php?m=content&c=index&a=show&catid=21&id=1595>.
[15] The report on the prospecting project identifies four sites as "very good," 11 sites as "good," ten sites as "moderate," and 19 sites as "poor."

Image 1: Locations of deposits classified as "very good"

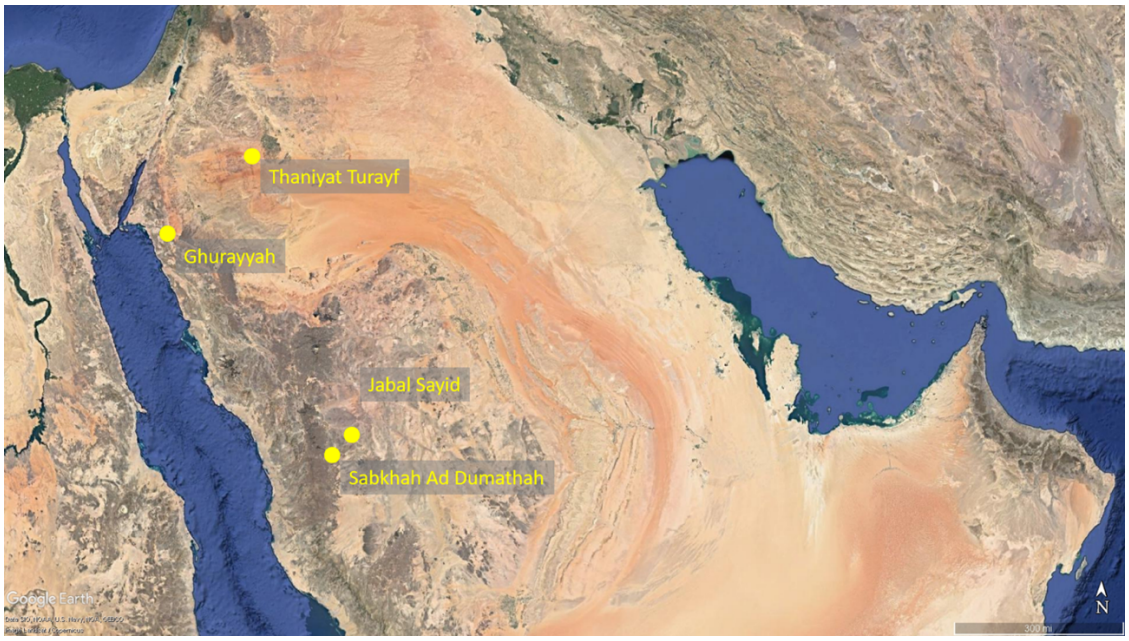

Image Source: Google Earth

Table 1: Imagery Source Used

Site	Imagery Used
Thaniyat Turayf	GoogleEarth (partial coverage 05/02/2013)/ Planet Labs (near daily 3 meter)
Ghurayyah	GoogleEarth (partial coverage 10/24/2011) /Planet Labs (near daily 3 meter)
Jabal Sayid	GoogleEarth (12/01/2018) /Planet Labs (near daily 3 meter)
Sabkhah Ad Dumathah	GoogleEarth (Two images at 2015/2019) /Planet Labs (near daily 3 meter)

The research team did not observe new activity at any of the four "very good" deposits, and currently assesses that Saudi Arabia is not mining uranium ore in these four locations, either with Chinese assistance or otherwise. CNS hopes to conduct a more complete analysis of the other candidate sites in the future.

Uranium Mill

The *Wall Street Journal* article alleged that a mill had been constructed with Chinese assistance close to the town of al-Ula. CNS researchers conducted a wide-area search using satellite imagery to identify possible locations of the mill. In addition to manually examining the area, CNS researchers also collaborated with Planet Labs, which maintains a map of all roads and buildings on earth extracted from satellite images, to conduct a machine-driven search of the area for new construction.[16] As a secondary criterion, CNS focused on facilities built since 2017, when Saudi–Chinese prospecting in the area started.

Researchers at CNS and other research organizations have identified a number of candidate facilities, none of which present clear signatures of a uranium mill. For example, the Institute for Science and International Security identified a candidate facility on the southern edge of al-Ula.[17] Researchers at CNS assessed this facility, which was built prior to 2017, to be a garbage incinerator.[18]

The research team also used information from the aforementioned uranium-prospecting documents in an attempt to identify the alleged mill. The map below shows the relative positions of the four candidate deposits and the town of al-Ula. As can be seen, al-Ula (the yellow pin) is some distance from each of the deposits (shown in green),

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[16] This produce is described at: Matt George, "Mapping All Of Earth's Roads And Buildings From Space," Planet.com, September 24, 2019, <https://www.planet.com/pulse/mapping-all-of-earths-roads-and-buildings-from-space/>.

[17] Institute for Science and International Security, Twitter post, August 5, 2020, 12:47 p.m., <https://twitter.com/TheGoodISIS/status/1291053165773828096>.

[18] Jeffrey Lewis, Twitter post, August 7, 2020, 1:53 p.m., <https://twitter.com/ArmsControlWonk/status/1291794654032084992>.

but al-Ula is relatively central among the prospect sites. Nonetheless, while it is possible to move ore by road to another part of the country, the research team did not identify any potential mill facility nearby, and considers it more likely that a mill would be built close to any deposit being mined. These observations tend to run counter to the allegation that a mill has been constructed in the al-Ula area.

Figure 1: Uranium Deposit Prospects in Saudi Arabia vs Al-Ula

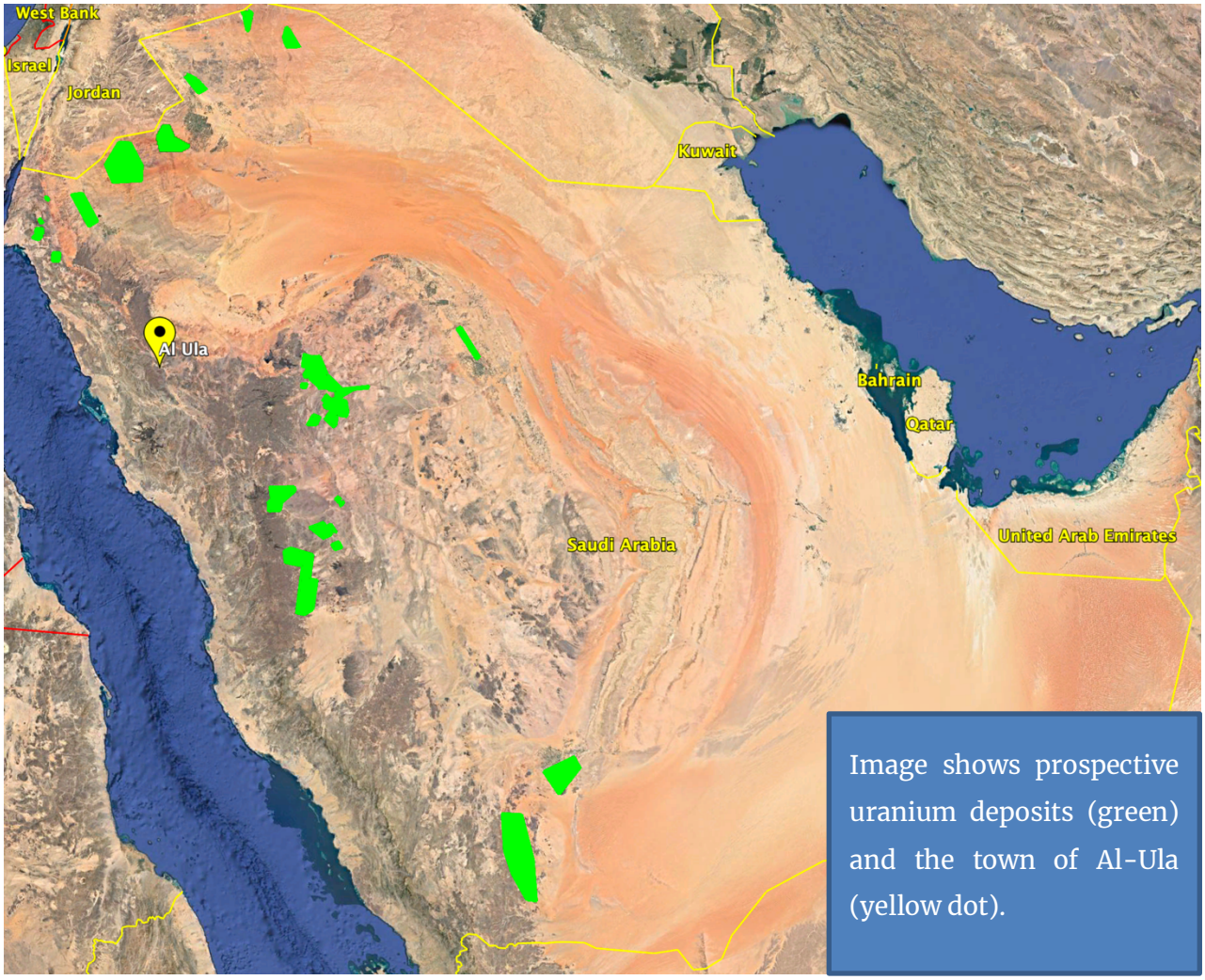

Image Source: Google Earth

Conversion Facility

The *New York Times* alleged that a uranium-conversion facility has been constructed near Riyadh. CNS has been unable to confirm the nature of the building in question. The research team notes the following points, however:

1) The site in question was constructed before 2017, predating the Saudi–Chinese uranium-prospecting project. This does not rule out the possibility of this being a conversion facility.
2) Since the CNS team did not locate any active mining or milling facility, if this facility is an active conversion facility, it is unclear where its uranium source material would originate. One possibility would be foreign-sourced uranium. Most states, including nuclear-weapon states like China, would have to declare exports of uranium to Saudi Arabia above a minimal threshold.[19] However, if KSA had introduced nuclear material into a conversion facility, it would be required to rescind its SQP and declare the facility to the IAEA. Failure to do so would be a violation of its CSA.

It is notable that the media reports on this topic, which have been informed by governmental sources, have not alleged a safeguards violation in KSA. The absence of such an allegation suggests that uranium has not yet been introduced to the alleged facility. In turn, this suggests that there is no known foreign source of uranium.

[19] See INFCIRC/207 and IAEA GOV/2588.

Conclusions and Broader Findings

Saudi Arabia is moving to develop an indigenous nuclear fuel cycle and Chinese entities have assisted KSA at least in prospecting for uranium. China is already involved in other parts of KSA's nuclear program, such as the development of advanced reactor designs.[20] China was also shortlisted by KSA as one of five potential suppliers for its two nuclear power plant units and it has supplied KSA with ballistic-missile capabilities.[21]

The research team has been unable to identify a mill or conversion facility and has observed no operational uranium mines at the four most promising deposits identified by the joint Sino–Saudi prospecting project. While this does not rule out the possibility that the allegations are true, these factors cast doubt on the existence of the facilities. More evidence would be needed to conclude that Saudi Arabia is in fact building these facilities.

The case highlights the limitations of safeguards in Saudi Arabia. For example, KSA presently would not have to declare the construction of a conversion facility until nuclear material is introduced to it, potentially after construction. It is vital that KSA rescind its SQP and conclude an AP with the IAEA. China and other potential nuclear suppliers should require this as a condition of supply.

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[20] See K.A.CARE, "Updates on Saudi National Atomic Energy Project (SNAEP),"<https://nucleus.iaea.org/sites/htgr-kb/twg-smr/Documents/TWG-2_2019/B07_Updates%20on%20Saudi%20National%20Atomic%20Energy%20Project%20(SNAEP)%20for%20IAEA%20SMR-TWG%2020190708.pdf>.

[21] On the nuclear power plant point, see Davi Knott, "Saudi Shortlists Nuke Vendors," April 24, 2020, <https://www.mees.com/2020/4/24/news-in-brief/saudi-shortlists-nuke-vendors/f3253fa0-8620-11ea-b0e4-2da154f19b57 and https://www.kapsarc.org/file-download.php?i=54647>. On ballistic missiles, see Ethan Meick, "China's Reported Ballistic Missile Sale to Saudi Arabia: Background and Potential Implications," U.S.-China Economic and Security Review Commission Staff Report, June 16, 2014, <https://www.uscc.gov/sites/default/files/Research/Staff%20Report_China's%20Reported%20Ballistic%20Missile%20Sale%20to%20Saudi%20Arabia_0.pdf> and "U.S. Confirms Saudi Ballistic Missile Production," *Arms Control Today*, July 2019, <https://www.armscontrol.org/act/2019-07/news-briefs/us-confirms-saudi-ballistic-missile-production>.

Finally, the future direction of the Saudi nuclear case is an important one. A more comprehensive review of all deposits—rather than only deposits classified as "very good" by the Chinese prospecting company—is required. A further important question is whether China continues to support KSA in developing its uranium resources. China is likely to do so primarily if these resources are commercially viable. Should KSA proceed without Chinese support, it would suggest that the resources are not commercially viable. This again would raise questions about Saudi Arabia's nuclear intentions.

While Saudi Arabia is taking steps to develop its indigenous nuclear fuel cycle, and appears to be keeping its nuclear options open, it is still a long way from having an indigenous nuclear program.

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