Chapter 12A. Summary of the North Takhar Placer Gold Area of Interest

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Abstract

This chapter is a summary of past investigations and assessments of the alluvial gold placer deposits in the Takhar area of interest (AOI) and its subareas. This summary is the result of geologic and compilation activities conducted during 2009 to 2011 among the U.S. Geological Survey, the U.S. Department of Defense Task Force for Business and Stability Operations, and the Afghanistan Geological Survey.

The source of placer gold in the North Takhar area is largely derived from denudation preexisting and to a lesser extent from existing endogenic hydrothermal vein or skarn deposits exposed within the orogenic uplifts of the Badakhshan and North Pamir Mountains. The first evidence of detrital gold occurs in early Pliocene age molasse deposits that were shed into the subsiding fore-Badakhshan trough (or Kulyab Megasyncline) of the eastern Afghan-Tadjik Depression. Subsequent tectonic uplift, being both continuous and episodic, of these gold-bearing deposits from the Middle Pliocene to Recent (Holocene) has resulted in multiple successive erosional cycles that are locally associated with the concentration of placer gold deposits.

The North Takhar AOI contains one of the two largest gold placers in Afghanistan. Containing several commercial grade reserves within the 6,000-square kilometer AOI, the largest reserve at Samti has estimated reserves more than 30,000 kilograms. The previously published data on the Takhar placers were collected before the development of satellite-based remote sensing platforms and several new methods of geomorphic mapping that use digital terrain models and geographic information system processing techniques. These new technologies and techniques may be integrated with previously collected borehole sampling data and geomorphologic interpretations to reassess the alluvial gold placer deposits in the Takhar region.

12A.1 Introduction

Placer gold deposits are found in two principal regions in Afghanistan. The first region is located in northeastern Afghanistan in the provinces of western Badakhshan and northern Takhar. The second region comprises a belt of permissive zones in the Ghazni, Kandahar, and Zabul Provinces in southwestern Afghanistan. This chapter is a summary of past investigations and assessments of the alluvial gold placer deposits in the Takhar area of interest (AOI) and its subareas. This summary is the result of geologic and compilation activities conducted during 2009 to 2011 among the U.S. Geological Survey, the U.S. Department of Defense Task Force for Business and Stability Operations, and the Afghanistan Geological Survey (AGS). The previously published data on the Takhar placers were collected before the development of satellite-based remote sensing platforms and several new methods of geomorphic mapping that use digital terrain models (DTM) and geographic information system (GIS) processing techniques. These new technologies and techniques can be integrated with previously collected borehole sampling data and geomorphologic interpretations to reassess the alluvial gold placer deposits in the Takhar region. By combining the historical borehole and cross-section data of sampled placers and the new terrain modeling and satellite imagery, further studies may be conducted to reassess the placer deposits and thus develop higher resolution estimates of gold placer targets and their potential for artisanal (small-scale mining using traditional methods) and industrial mining in Afghanistan.

12A.2 Study Area

Takhar Province is located in northeastern Afghanistan and shares its northern border with Tajikistan (fig. 12A–1). With a population estimated to be more than 870,000, Takhar is an ethnically diverse region comprising Hazara, Pashtun, Tajiks, Turkmen, and Uzbeks (U.S. Agency for International Development, 2010). The capital of the province is Taloqan, which lies less than 70 kilometers (km) east of the provincial city of Kunduz, which is connected to Kabul and Mazar-e-Sharif by good, paved roads.

Figure 12A–1. General location map showing the North Takhar area of interest in Takhar Province.

Natural resource uses in Takhar Province include nominal agriculture and mining. Agriculture includes pistachio forests that are slowly being revived after decades of war, and these may be an important part of the future economy, as they have been in the past (U.S. Agency for International Development, 2010). Mining resources are more varied but of small scale. Coal reserves of fairly good quality are being exploited by hand in some villages and sold within the region (GRM International, 2006). Gold is currently mined by artisans throughout the province and there have been reports of about 2 kilograms (kg) of gold being marketed at specific weekly markets in Takhar (GRM International, 2006). Large deposits of fine salt are located in Takhar, and a growing number of salt mines have sprung up to supply the population in northern Afghanistan with iodized salt (GRM International, 2006). Industrial minerals, such as sand and gravel are also widely available.

The Panj River forms the border between Tajikistan and Afghanistan; it is narrow, shallow, and fast-moving. The Panj River and its tributaries, which largely run through a series of adjacent riverbeds, form the topographic lows throughout the study area. Because precipitation and snow melt dictate the discharge of the Panj, the river's flow is highly variable and dependent on seasonal climatic conditions.

The general topography of the province and surrounding region is characterized by rough mountainous terrain amidst a series of adjacent alluvial valleys. Elevations commonly range from

400 meters (m) to more than 2,800 m. The land cover of the area is dominated by rain fed agriculture in flat alluvial valleys and gently sloping terrains and rangeland and shrub land in the higher elevations (Afghanistan Information Management System, 2002).

The formal study area for the North Takhar placer gold occurrences is largely focused on the northern region of the Takhar Province and immediate bordering regions of western Badakhshan Province. The AOI is bounded on the east by longitude 70°10′ E and on the west longitude by 69°22′ E. To the south the AOI is bounded by latitude 36°51′ N and to the north by the Panj River, along the border with Tajikistan (fig. 12A–2).

12A.3 Literature Review

Gold mining in the Takhar region was documented as early as the end of the 13th century when Marco Polo visited Afghanistan. Although gold was certainly mined before that time, very few published accounts are known to exist. In 1937, E.F. Fox visited the Middle Panj region of Takhar Province, and a report was compiled after his trip on the basis of the oral communication with the native population. His visits to the Nuraba and Chah-i-Ab gold mining areas serve as a modern record for the region, although no active mining was noted and no geological samples were taken. In particular, Fox identified the region between the Kokcha and Chilkanshar Rivers as being promising for alluvial gold mining (Fox, 1943).

Two years later, AbdulKhan (1943), investigated the Huraba (Nooraba) and Chalkanshar (Chilkanshar) Rivers. He indicated in his report that the valleys of these rivers are famous for containing deposits of rare native gold of 70 to 80 miskal (l miskal = 4,577 milligrams) (Chaihorsky, 2010).

Abdullah Nasori of the Afghan Ministry of Mines subsequently conducted heavy concentrate sampling for gold in the Khasar, Kokcha, Nooraba, and Panj Rivers, the results of which were all positive. Following these tests several more studies were conducted in the late 1940s and early 1950s, including alluvial placer sampling, as well as lode gold exploration in Badakhshan and Takhar Provinces.

From 1958 to1977, Soviet geologists collaborated with the AGS to conduct a nationwide assessment of Afghanistan’s physical geography and natural resources. In partnership with the Afghan Ministry of Mines (MOM), the Department of Geology and Mines, Soviet geologists of the state-owned company, Technoexport, and the Soviet Geological Mission, produced hundreds of reports documenting the country’s vast mineral resources, yet most of these reports were never made publicly available. These reports, published alternatively in Dari, Russian, and (or) English, provide in situ and derived data of existing mineral deposits, as well as valuable topographic, geological, and hydrographic data. The reports contain a vast amount of information ranging from cross sections, detailed topographic maps, boreholes, and ground samples to accounts detailing prospecting and exploration activities.

In 1977, at the culmination of a 20 year partnership between Afghan and Soviet scientists, the two-volume report “Geology and Mineral Resources of Afghanistan” was published by Abdullah and others (1977). The result was a synthesis of the findings on Afghanistan’s known natural mineral resources that incorporates additional studies from German, French, and Italian geologists who worked in Afghanistan during the period. Recently, the British Geological Survey (BGS), in providing technical assistance to the AGS, republished this two-volume report with minor editing and formatting changes to update terminology and to make this volume more widely available (Abdullah and Chmyriov, 2008). Much of the geological literature assessing mineral and resource deposits is based largely on Abdullah and others (1977) and Abdullah and Chmyriov (2008) as well as other reports that have been acquired from the archives of the Afghan Geological Survey. Little new work or sampling has been carried out in Afghanistan because of the political and security situation in the country over the past 30 years.

This chapter reviews the findings of the key reports conducted in the Takhar gold district and seeks to place these in the context of modern technological modeling methodologies.

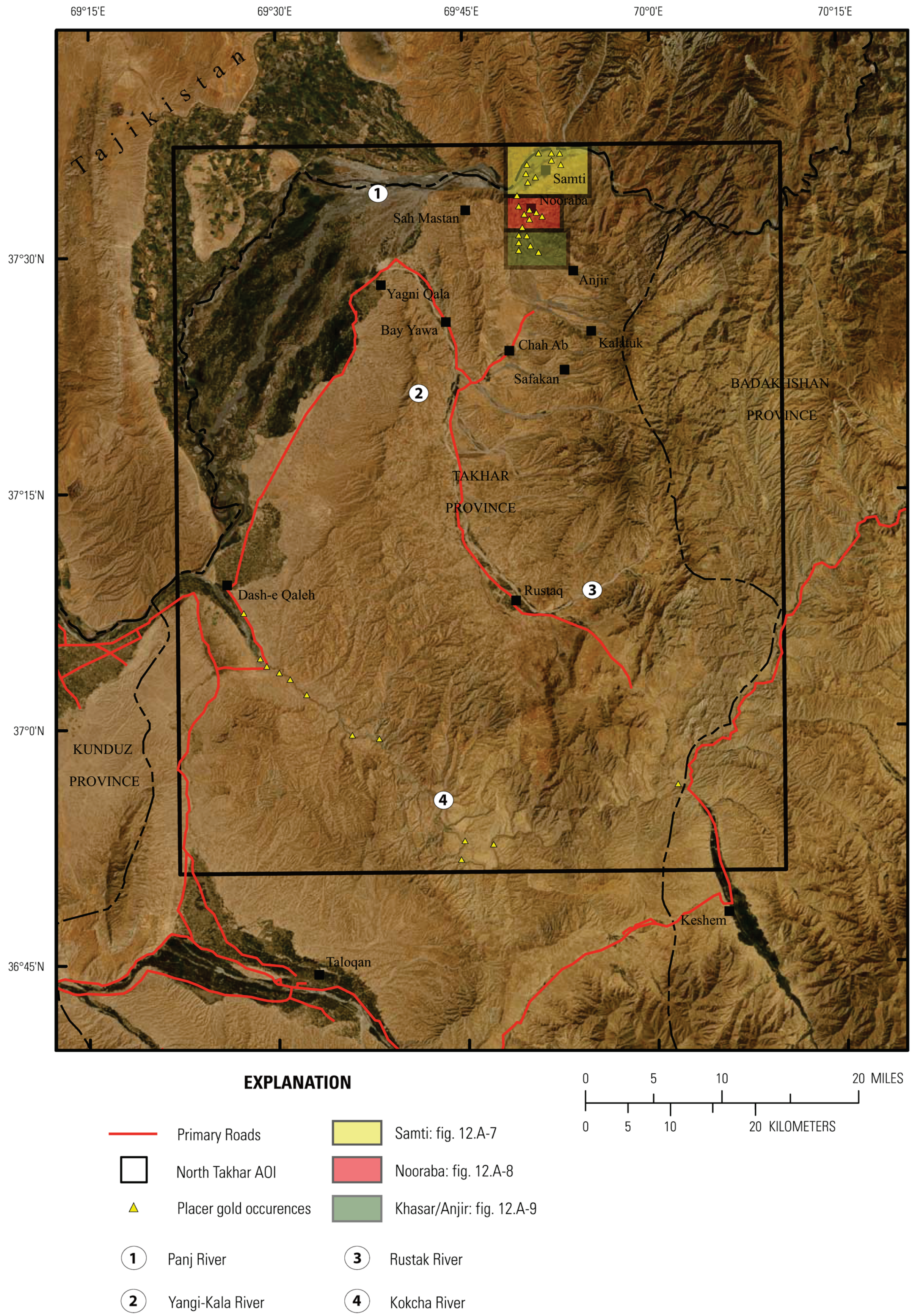

Figure 12A–2. Map showing the North Takhar area of interest, from Doebrich and Wahl (2006).

12A.4 Geologic Background

(Summarized from Galchenko and others, 1972)

The bedrock geology in the North Takhar AOI is largely comprised of variably resistant Miocene and Lower Pliocene molasse deposits (fig. 12A–3) that were folded into north-south trending anticlines and synclines during the middle Pliocene Tal'bar tectonic phase. Subsequent downcutting of the Panj River across the underlying geology was generally perpendicular to geologic strike and was affected by numerous Quaternary age neotectonic uplifts (Dodonov, 1980). As a result, variable rates of downcutting across the geologic structures together with channel realignment, capture, and rejuvenation occurred in the region. Erosion of variably resistant molasse deposits by the Panj River and its local tributaries, particularly into the lower Pliocene gold-bearing Karnack Formation, together with neotectonic adjustments on the river course, provide the controlling factors of narrowing and widening of the Panj River valley and the respective nonaccumulation and accumulation of placer gold.

Where the Panj River traverses the axes of the Khasar and Kharsang anticlines, the more resistant Miocene age core strata consisting of molasse deposits of the Baldzhuan, Khingou, and Tavildara Formations constrain the downcutting river system to a relatively narrow gorge-like course. Although detrital gold is present in these narrow stretches of the river, the hydraulic regime associated with downcutting was not conducive to the long-term accumulation and concentration of commercial placer deposits.

Conversely, within the region of the Anjir syncline, which is located between aforementioned anticlines, less resistant core strata of the Lower Pliocene gold-bearing Karnack Formation is exposed along the course of the Panj River. Along this length of the river valley, the width and the accumulation of detrital gold increase because of the variable rate of downcutting of the Panj River system through the Khasar anticline and the downcutting of subsequent tributary rivers and streams within less resistant strata of the Karnak Formation.

First, the rate of incision of the Panj River through the axis of the Khasar anticline varied owing to the differing resistances of Miocene age rock types that were encountered and to impedance by steady and episodic neotectonic uplift (Dodonov, 1980). For these reasons, upstream of the Khasar anticline, the flow regime of the Panj River was frequently retarded within the reach of the Anjir syncline. As a result, alluvial aggradation and meandering of the river course led to greater lateral erosion and widening of the river valley within the less resistant gold-bearing core strata of the Karnack Formation.

The second reason for valley widening within Samti area of the Panj River relates to the more rapid downcutting by subsequent tributary rivers and streams whose courses are controlled by the less resistant anticlinal core strata of the Karnack Formation. Examples on the Afghan side of the Panj River would include the ancient middle Quaternary age paleovalley that extends between Chah-i-Ab and the Panj River, possibly an ancient course of the Panj River before its current tectonic alignment, and the Khasar River. Examples in adjacent Tajikistan would include the Chagan and Dulyabi-Sangou Rivers. Within this widened river segment of Samti, the reduced flow regimes were more conducive to alluvial aggradation and accumulation of detrital gold deposits.

12A.5 Stratigraphy of the Placer Deposit Zones

(Summarized from Abdullah and Chmyriov, 2008)

Neogene and Quaternary molasse deposits constitute much of the stratigraphic succession within the Samti gold-bearing area and the larger encompassing permissive placer gold region (fig. 12A–4). Initial deposition commenced in Paleogene-Neogene time in response to continental collision between the Eurasian and northward advancing Indian Plates, and continues to present. In northern Takhar and adjacent Badakhshan Provinces, the molasse succession accumulated within a subsiding structural basin called the fore-Badakhshan trough or Kulyab megasyncline. The basin developed adjacent to the western strike-slip margin of the uplifted Badakhshan orogenic belt and the overthrust margin of the uplifted North Pamir Mountain belt orogenic.

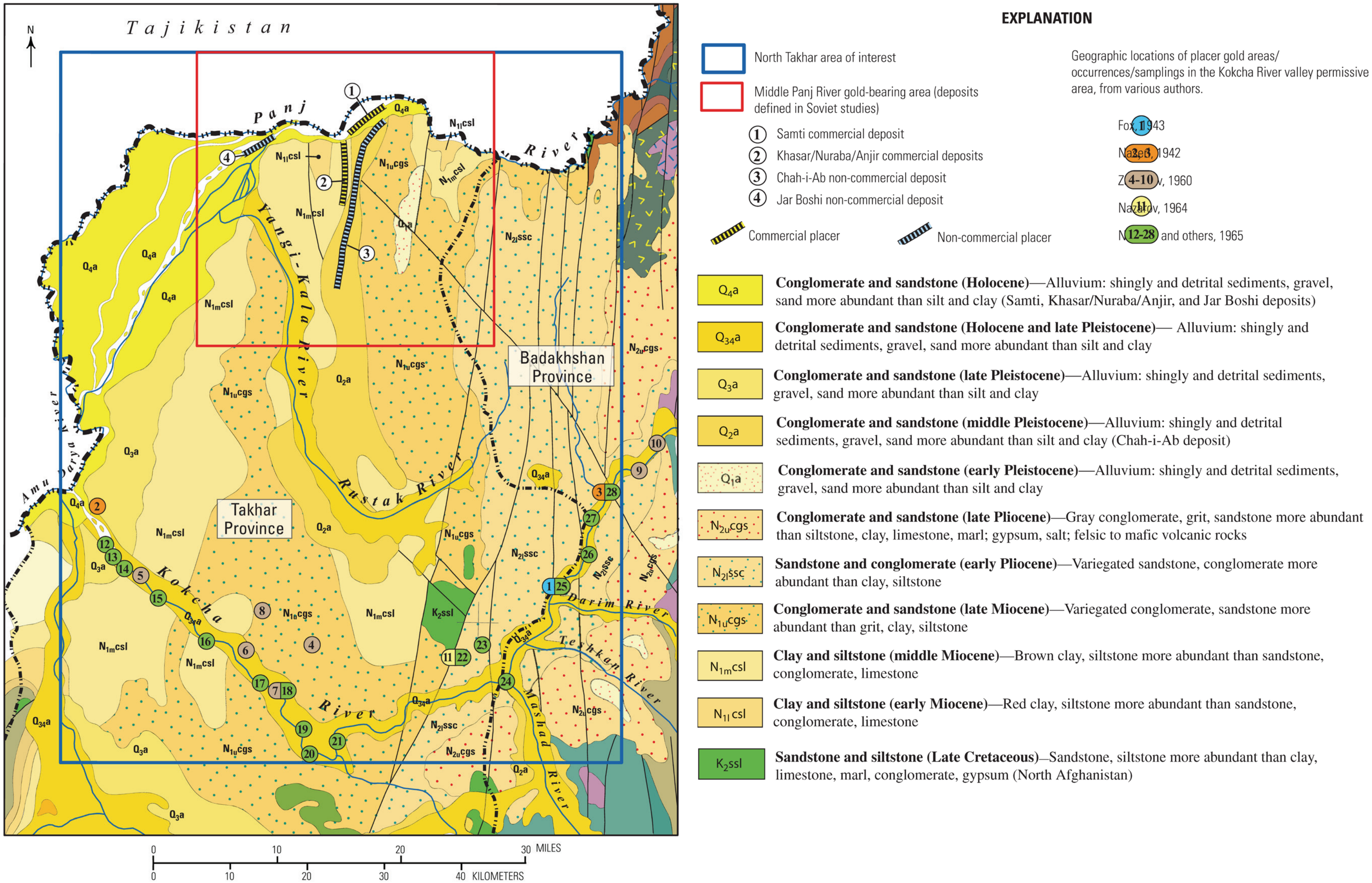

Figure 12A–3. Geologic map of northern Takhar and westernmost Badakhshan Provinces, Afghanistan, showing the distribution of Neogene and Quaternary age strata (mostly alluvial molasse and aeolian) and localities of lode and placer gold. Gold-bearing placer deposits are associated with middle Pleistocene age (Q_2a) basal alluvial conglomerates composing ancient elevated terraces (Chah-i-Ab deposit) and within modern Holocene age (Q_4a) alluvial river and stream deposits (Jar Boshi, Khasar/Nuraba/Anjir, and Samti deposits). Geologic map is modified from Doebrich and Wahl (2006); gold localities are from Abdullah and others (1977) and Abdullah and Chmyriov (2008).

Neogene deposits in the Kulyab megasyncline are composed of a continuous succession of Miocene and Lower Pliocene clastic rocks that are disconformably overlain by Quaternary alluvial and aeolian deposits. The disconformity, a time interval marked by the absence of middle and late Pliocene rocks, likely represents the Tal'bar tectonic phase. During this tectonic phase, Miocene and lower Pliocene strata that once fully blanketed the region were subjected to folding, faulting, and uplift, and with subsequent erosion, their record has either been partly or fully removed.

Quaternary deposits largely consist of widespread aeolian loess deposits that record a climate regime that alternates between wetter interglacial and drier glacial periods. Throughout the Quaternary, as many as three episodic tectonic events have uplifted and stranded lower, middle, and upper Quaternary deposits as discrete, laterally traceable elevated terraces. Each terrace deposit commonly comprises a couplet that includes the following: a lower coarse-grained boulder-sand-pebble alluvial part, commonly thinner, channel-form, and gold-bearing, which represents erosive downcutting following uplift, and a thicker overlying succession of glacial deposits that exhibits evidence of cyclical interglacial wet periods.

Within the 1:50,000 scale geologic map area of the Samti gold-bearing deposits (Galchenko and others, 1972), map units include strata of from the early, middle, and late Miocene, the early Pliocene only, and the early, middle, and late Pleistocene and recent (Holocene) of Quaternary age. Galchenko and others (1972) provide detailed lithologic descriptions of these strata; however, they only provide paleontologic analysis of the late Miocene and early Pliocene age deposits. On the basis of biostratigraphy and lithostratigraphy the upper Miocene and lower Pliocene are correlated to the better studied type areas and sections in adjoining Tajikistan, whereas the lower and middle Miocene strata are correlated to Tajikistan on the basis of lithostratigraphy and superposition only. They do not provide paleontologic analysis for Quaternary deposits that, on basis of superposition, composition, topographic distribution, and structural relationships (faulting), are subdivided into lower, middle, and upper Pleistocene and Recent (Holocene).

12A.6 Mineralogy

12A.6.1 Sources of Endogenic Lode Gold

Localities of endogenic lode gold are the likely primary sources for the Middle Panj River placer deposits, and principally occur in Badakhshan Province with lesser amounts in Takhar Province (Abdullah and others, 1977; Abdullah and Chmyriov, 1980, 2008). Known lode gold localities are distributed between three metallogenetic zones (MZ): Surkab-Jaway, Western Badakhshan, and Central Badakhshan (fig. 12A–5). In the Surkab-Jaway and Western Badakhshan MZs, gold mineralization is associated with igneous emplacements that commonly co-occurred with periods of tectonic deformation of Proterozoic through Triassic age basement rocks of Hercynian folding. In combination, these MZs are congruent with the tectonic zone of Hercynian folding of the Afghanistan-North Pamir Region that forms the Hindu Kush and North Pamir orogenic uplifts. In the Central Badakhshan MZ, gold mineralization is related to igneous emplacements that co-occurred during the consolidation or accretion of various terranes from Cretaceous to Paleogene. This MZ is largely congruent with the tectonic zone of Middle Kimmerian Folding of the Afghanistan-South Pamir Region that forms the South Pamir orogenic uplift.

12A.7 Gold Mineralogy

Galchenko and others (1972) distinguish three varieties of gold at the Samti deposit on the basis of color, roundness, assay number, inclusions of accessory minerals, and mineral habit. From these criteria, the provenance of at least two gold varieties can be assessed.

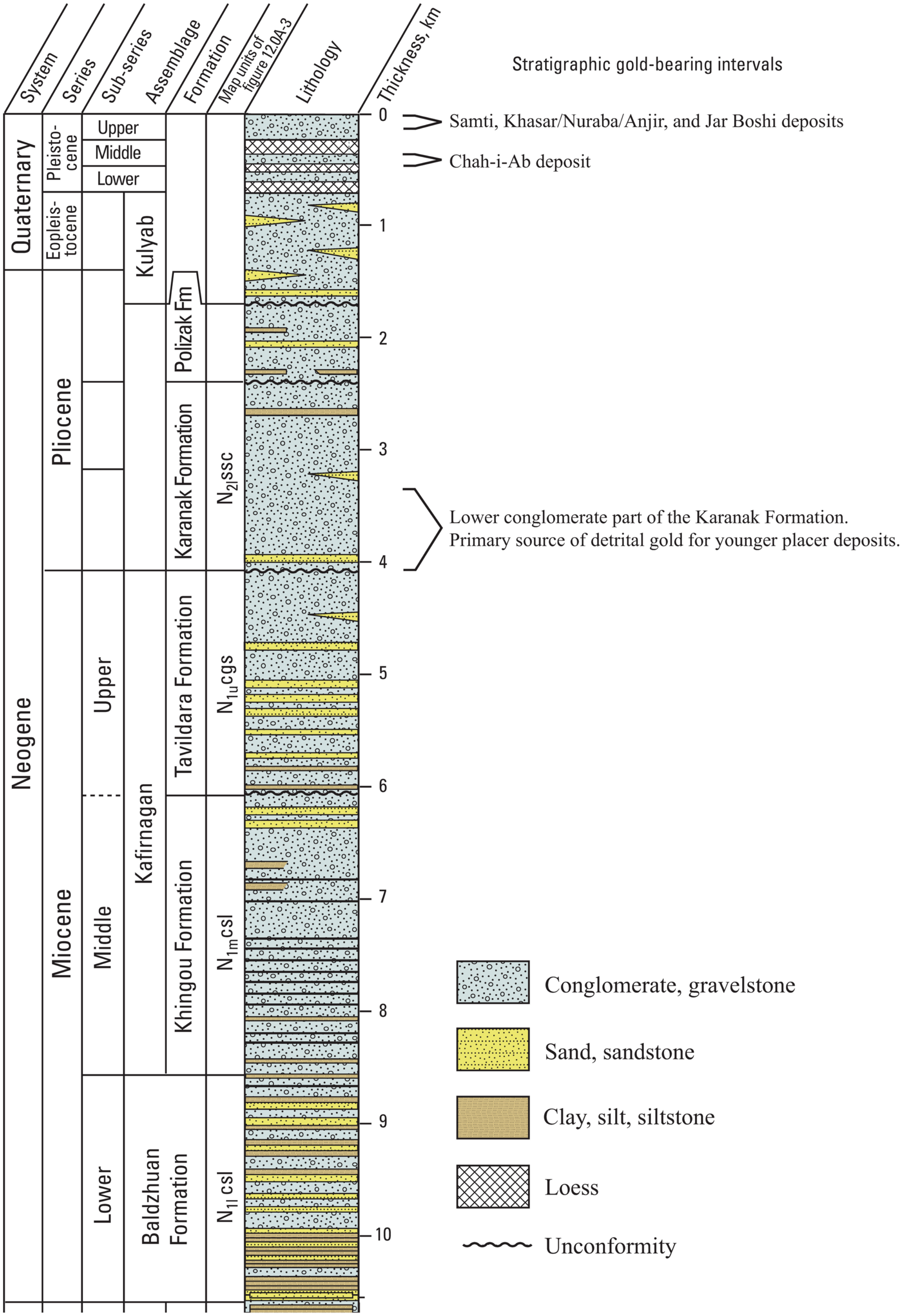

Figure 12A–4. Composite lithologic column for Paleogene, Neogene, and Quaternary age molasse deposits of the Afghan-Tajik depression (reproduced from Nikolaev, 2002).

The first variety predominates at the Samti deposit. It is yellow to dark yellow in color, dull in luster, has perfect or good roundness (rounded to well rounded), and an assay number of 900–910. The grains are mostly flat plates, seldom hexagonal or isometric, with rare coatings of powdery iron hydroxide. Mineral inclusions include amphibole and staurolite. Relicts of an original coarse-grained crystalline texture have been entirely recrystallized to fine grained and later locally to coarse grained. The recrystallized fine-grained gold occurs in zones associated with sliding (deformation), where it was likely formed.

From these criteria, this variety of gold was recycling through multiple phases of placer deposition over an extended period of time. On the basis of available local sources, this gold is likely either derived directly from the ancient placer gold-bearing conglomerates of the lower Pliocene Karnack Formation and (or) from a series of younger, intermediate placer systems. For the latter this would include the middle Quaternary gold-bearing conglomerates forming the thalweg of the uplifted paleovalley, whose recycled gold is derived from the lower Pliocene Karnack Formation, and recent (Holocene) alluvial placer deposits of the modern Anjir, Khasar, and Nuraba hydrographic system, whose recycled gold is derived from both of the aforementioned placer systems. The attributes of the first variety of gold, given above for the Samti deposit, are expected to be similar for the older placer deposits.

The second gold variety is subsidiary in quantity. It is light greenish yellow to golden yellow in color, dull in luster, has an average roundness (subrounded to rounded), and has an assay number of 860–870. The grains are mostly plates, being thinner than the first variety of gold, and have ragged edges, protrusions, and burrs, and occasionally lumpy and rounded grains occur. These grains lack mineral inclusions but have a carbonaceous encrustation. The mineral habit is commonly monocrystalline, with occasional twinned and recrystallized grains. Evidence of corrosion on these grains suggests both shorter period of residence time and transport distance in the local placer system(s). On the basis of these criteria, probable sources of the second variety are the numerous lode gold deposits within the Davang River drainage, located approximately 30 km upstream of Samti.

The final variety of gold, referred to as copper gold, is rare and has an irregular vertical and lateral distribution. Therefore, it is not considered in the reserve estimates of the Samti deposit. The grains are yellowish red in color, exhibit a bright rosy streak test color, have average roundness (subrounded to rounded), and are platy and occasionally lumpy in shape. The assay number is 609–618. The recrystallized gold has a polygonal, medium-grained texture. Grains may be corroded and have mineral inclusions.

12A.8 Known Placer Deposits

Two commercial and two noncommercial placer gold deposits, and as many as twenty mechanical halos are recognized in the middle Panj River region and permissive area (fig. 12A–3) (Abdullah and others, 1977; Peters and others, 2007; Abdullah and Chmyriov 2008). The mechanical halos are zones of increased content of chemical elements in natural formations associated with deposits of gold. Table 12A–1 shows a summary of previous estimates of alluvial gold resources and permissive sites where positive sampling results were obtained. As a result of these estimates developed by previous researchers, a series of commercial placer deposits, noncommercial deposits, and permissive areas have been identified in the North Takhar AOI.

The commercial deposits include the Samti placer and Nuraba-Khasar-Anjir placers, each being associated with alluvial systems and each the focus of numerous prospecting expeditions by Soviet geologists. The Samti deposit is located in the Panj River valley. The Nuraba-Khasar-Anjir deposit is located in the lower reaches of several lesser named rivers and streams that are either direct, or indirect, tributaries of the Panj River at Samti.

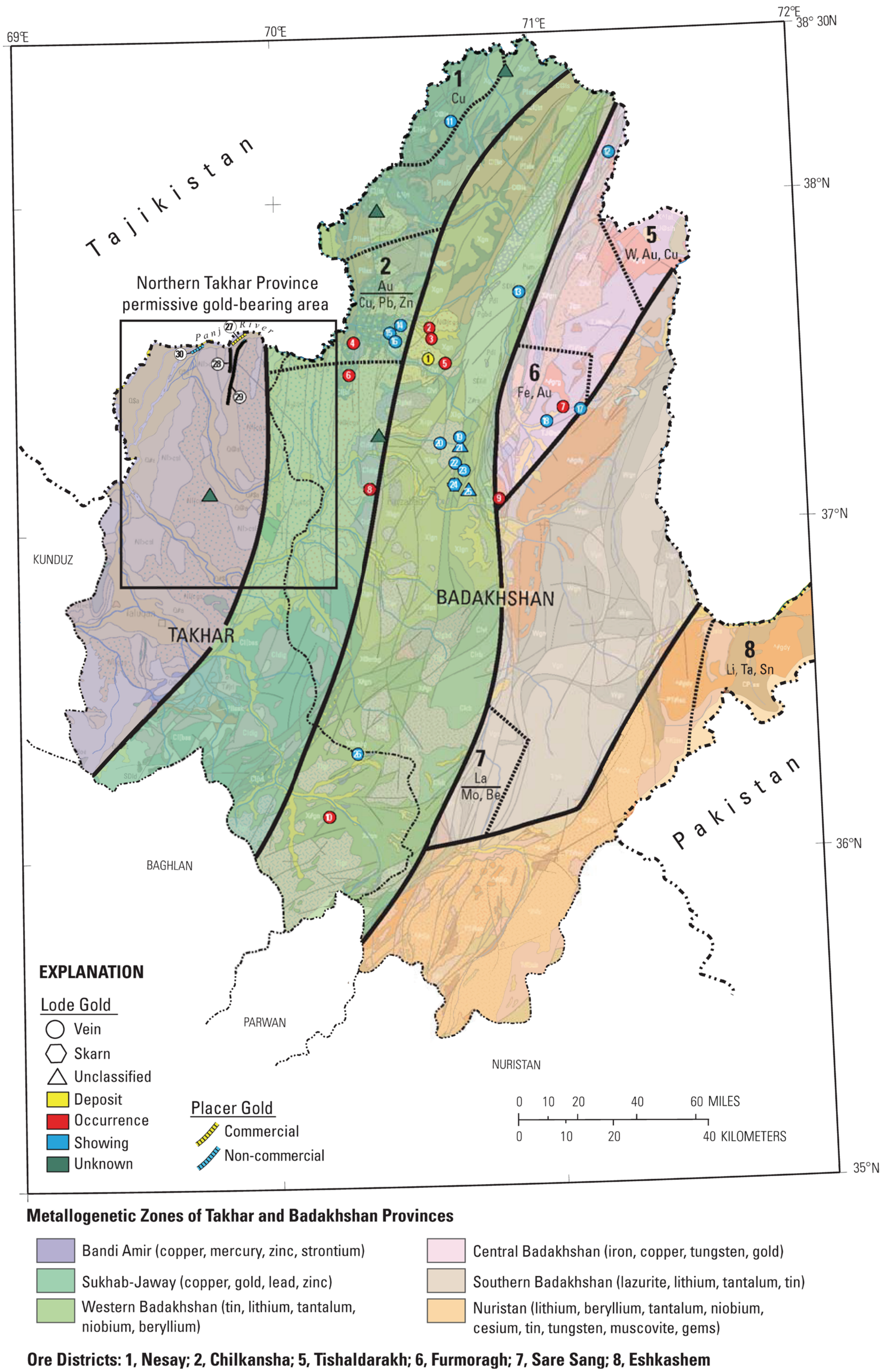

Figure 12A–5. Map showing metallogenic zones of Takhar and Badakhshan Provinces of Afghanistan, from Doebrich and Wahl (2006).

Table 12A–1. Alluvial gold resource estimates for the North Takhar area of interest.

[Modified from Galchenko (1975a). —, no data; kg Au, kilograms of gold; km, kilometers; km^2, square kilometers; m, meters; mg/m^3, milligrams per cubic meters]

Deposit	Province	Length (km)	Width (km)	Area (km^2)	Depth of overburden (m)	Thickness of gold-bearing seam (m)	Average gold content (mg/m^3)	Resource estimate (kg Au)
Known placer deposits								
Samti	Takhar	8	0.9–1.7	8–12	29.8	1.6	3,092	30,062
Nooraba	Takhar	—	.05–.1	—	5	1.0–3.0	100–760	210
Khasar	Takhar	4.6	.03–.1	0.138–.46	9.9	1.05–3.0	90–19,000	437
Anjir	Takhar	2.3	.02–.07	.046–.161	7.3	1.0–2.8	123–2,716	155
Prospective placer deposits								
Jar Boshi	Takhar	6	1–1.5	6.0–9.0	—	1.5	100–600	—
Chah-i-Ab	Takhar	—	—	—	—	—	Indicated	—

12A.8.1 Samti Deposit

The Samti placer occurs along the middle span of the Panj River and is situated in the Panj valley between the mouths of the Varichi stream and Khasar River valleys. It is about 8 km in length and varies from 900 m to 1.7 km in width. A large part of the Samti placer lies within an active flood plain, which has restricted some exploration (Galchenko and others, 1972; fig. 12A–6).

Previous estimates of gold resources throughout Samti were calculated to be 31,432 kg, with the average content throughout the entire mass of alluvium calculated to be 408 milligrams per cubic meter (mg/m^3), and the average depth of the mineralized alluvium is 31.5 m. Potential gold resources may be found in 40-m-high terraces and alluvial fans of the Panj River tributaries located above the alluvial plain.

Three workable zones have previously been identified within the Samti Placer, the right, the central, and the marginal (Galchenko and others, 1972; Abdullah and others, 1977; Abdullah and Chmyriov, 2008). The right placer is 5 km in length and ranges from 90 to 490 m in width. Soviet borehole investigations revealed an average gold content of 493 mg/m^3 at an average depth of approximately 31 m for this deposit.

The central placer consists of two uniformly mineralized zones. The placer is 3.8 km in length and 80 to 450 m in width, averaging 22.8 mg/m^3 gold. The marginal placer is situated on the left side of the valley. Two workable pay streaks were identified, the right and the left. The right streak is 1.8 km in length and 80 to 160 m in width, with an average gold content of 258 mg/m^3 (Galchenko, 1975a). The left streak is 1.48 km in length and 80 to 280 m in width, with an average gold content of 375 mg/m^3 (Galchenko, 1975a). More than 400 boreholes and samples were collected in the Samti area over the years by previous researchers. For each borehole location a GIS database was developed which records the depth, thickness of overburden, grade of gold bearing alluvium, as well as additional available information. The locations of the boreholes and sample sites are shown in the figures accompanying the description of the placer deposits.

12A.8.2 Nooraba (Nuraba) Deposit

The second commercial gold bearing placer is generally referred to as the Nuraba deposit. It is associated with Holocene age alluvial deposits that are located within the narrow, fault controlled lower reaches of the Khasar River, a direct tributary of the Panj River, and the Nuraba and Anjir streams, that are tributaries to the Khasar River. The active hydrographic system of these river and stream drainages further concentrate detrital gold derived from the uplifted, Middle Quaternary age thalweg conglomerates of the noncommercial Chah-i-Ab deposits which they deeply incise.

In total, 60 borehole and cross section sample points were converted into the GIS database from Soviet investigations. These boreholes, shown in figures 12A–7 and 12A–8, represent the data from which further refinement of geomorphic study of the placer deposits can be made.

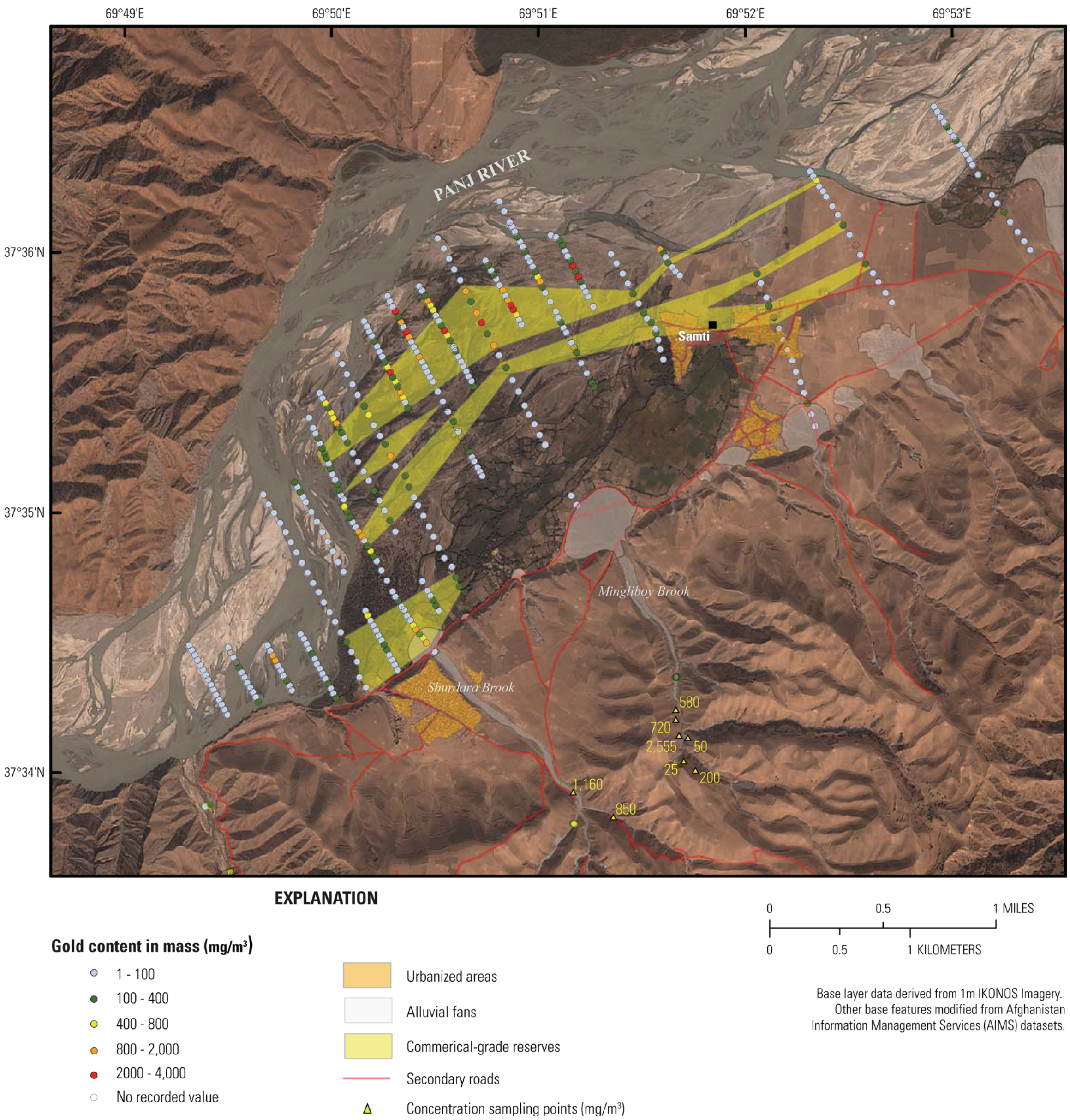

Figure 12A–6. Map showing Samti placer deposit and borehole data collected by Soviet researchers.

Alluvial deposits constituting the valley flat of the Nooraba stream are noted to be 50 to 100 m in width; in the Khasar River valley they vary from 80 to 120 m in width; and in the Anjir stream valley they vary from 50 to 150 m in width (Galchenko, 1975b; fig. 12A–8). The alluvium commonly ranges from 7 to 14 m in thickness. The Nooraba placer deposit is 3.8 km long and varies from 10 to 50 m in width, the Khasar River placer is 4.6 km long and 30 to 100 m wide, whereas the Anjir placer deposit is 2.3 km long and 20 to 70 m wide (Galchenko, 1975b). The concentrations of gold in the auriferous beds are not uniform, varying from as little as 90 to 100 mg/m^3 to as much as 19 g/m^3. The overburden is also auriferous but not economical for mining and the gold concentrations range from several milligrams per cubic meter to 300 mg/m^3 (Galchenko, 1975b). In the Nooraba placer the auriferous bed varies from 1 to 3 m in thickness and has a gold content that varies from 100 to 760 mg/m^3. In the Anjir valley the auriferous bed is 1 to 2.5 m thick and contains between 123 and 2,716 mg/m^3 gold.

The gold reserves are estimated to be 437 kg in the Khasar Placer, 210 kg in the Nuraba Placer, and 155 kg in the Anjir Placer (Popenko and Teplykh, 1970; Galchenko, 1975b).

12A–9 Chah-i-Ab and Jar Boshi Prospective Placer Deposits

Noncommercial prospective deposits include Chah-i-Ab and Jar Boshi. Chah-i-Ab is associated with middle Quaternary gold-bearing conglomerates that are exposed within an ancient, uplifted paleovalley extending between the town of Chah-i-Ab and the Panj River, a north-south distance of approximately 30 km. Jar Boshi is associated with the recent alluvial system of the Panj River valley, located approximately 13 to 18 km west of the Samti deposit. The Jar Boshi deposit, of complex structure, is a combination of small channel-bed, river-bar, and terrace placers that cover an area measuring 6 km by 1 to 1.5 km. The placer has been worked to a depth of 1.5 m, with the average gold value being 100 to 600 mg/m^3. As reported in work by Abdullah Nasseri in 1942, the gold content of the placer is 1,500 mg/m^3 (Galchenko and others, 1972).

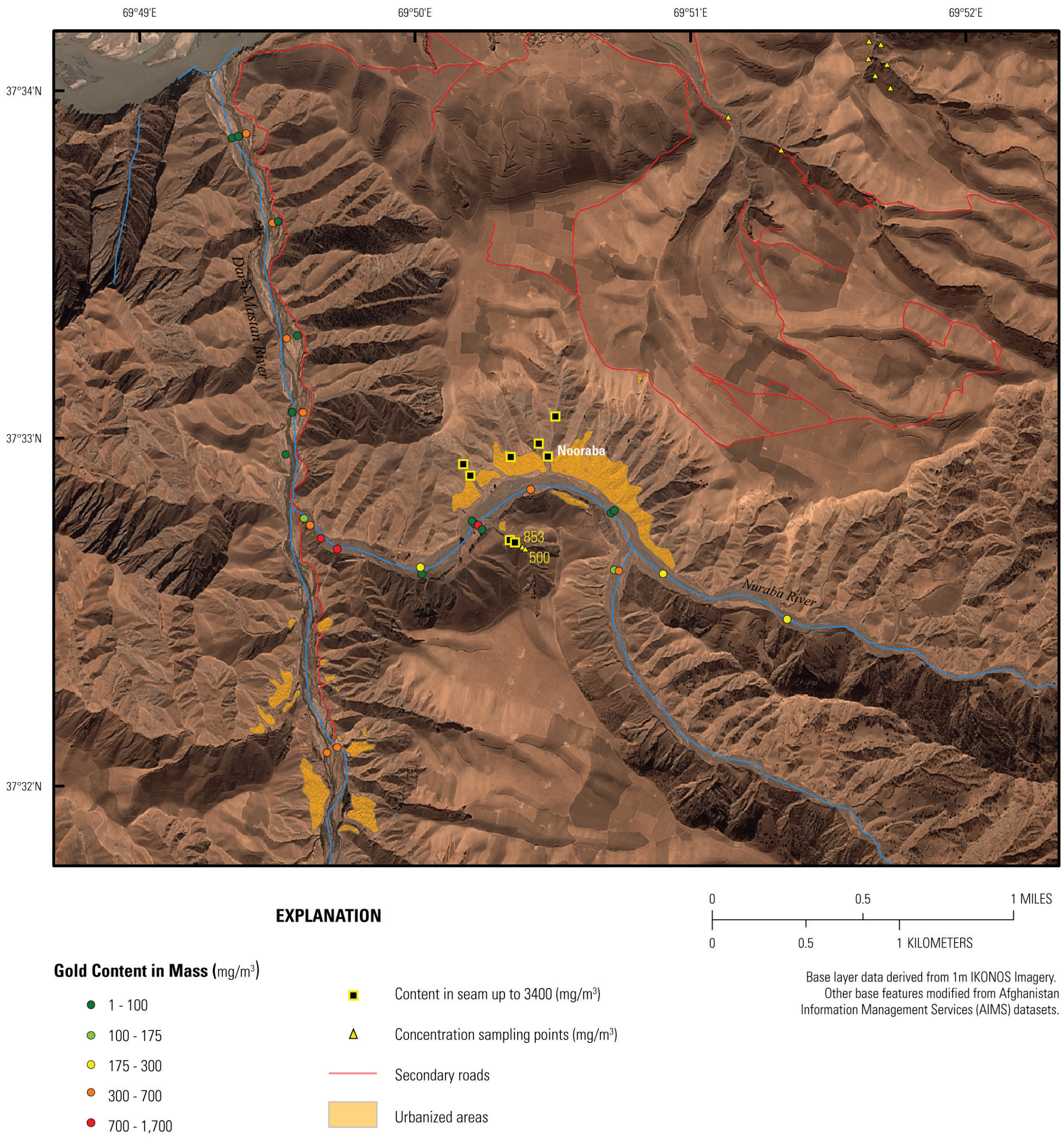

Figure 12A–7. Map showing Nooraba placer deposit and borehole data and cross-section locations.

12A.10 Mechanical Mineralogical Halos

Table 12A–2 provides a brief description of the geology and gold content of twenty mechanical mineralogical halos, which occur in Badakhshan and Takhar Provinces. The summarized locality information provided by Abdullah and others (2008) is commonly nonspecific and (or) poorly defined and, when provided, generally refers to geographic place names of rivers and (or) their drainage basins. In some cases a river and its drainage basin can be specifically restricted to a province, such as the Shewa, Rawenjaj, Ragh , and Yaftal Rivers, among others, of Badakhshan Province. In other cases, as with the larger Kokcha River, their course and watershed span both provinces. These halos are deemed to warrant further investigation.

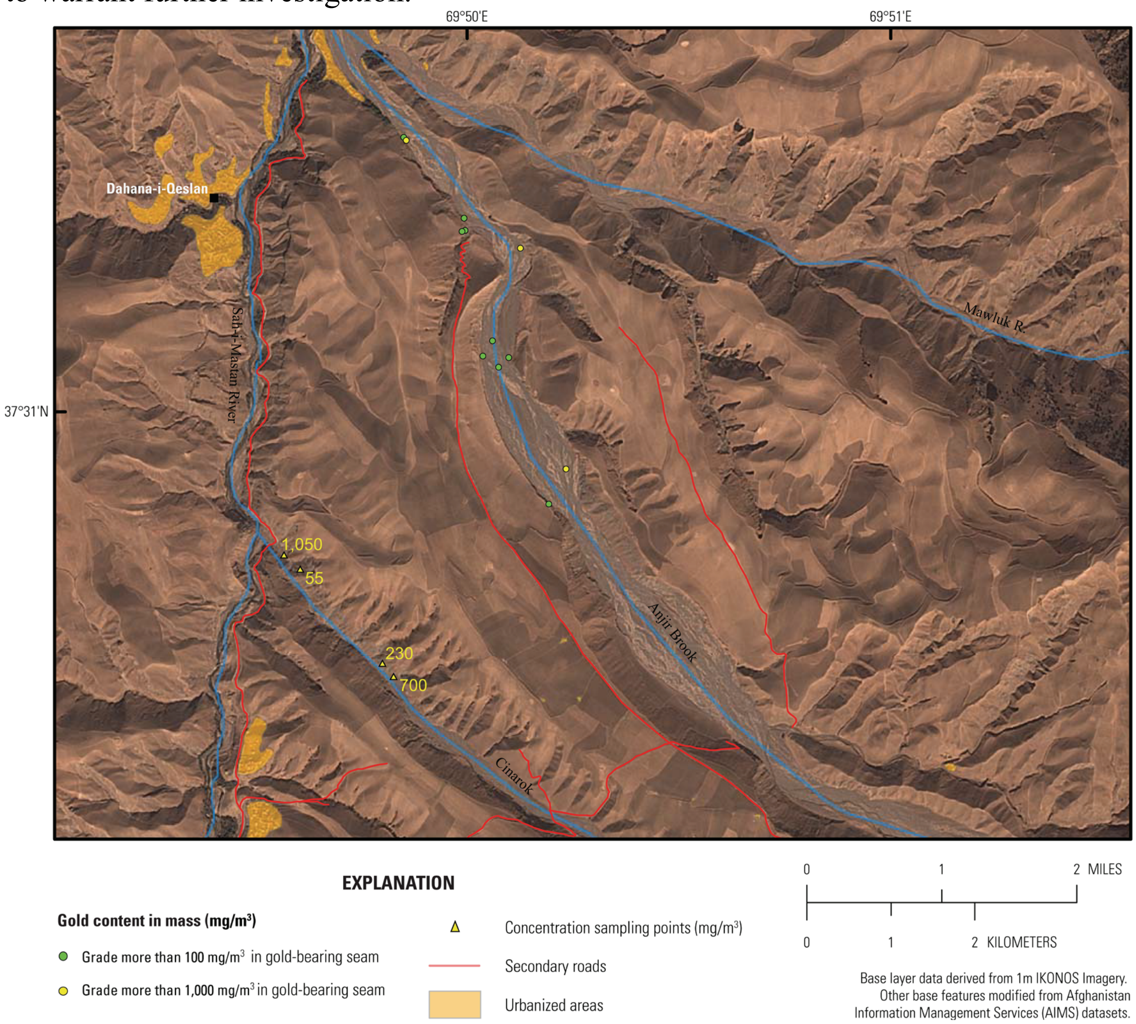

Figure 12A–8. Map showing the Khasar and Anjir placer deposit and borehole data and cross sections collected by Soviet researchers.

12A.11 Badakhshan Permissive Area

Eighteen mechanical mineralogical halos are widely distributed throughout Badakhshan Province. Eleven halos occur in the watershed of the Panj River of northern Badakhshan, six occur in the middle and upper reaches of the Kokcha River watershed of southern Badakhshan, and one is identified to span the interfluves of the Yangi-Kala and aforementioned rivers of westernmost Badakhshan.

Within the Panj River watershed of northern Badakhshan, sampling by Semionov and others (1967), Sborshchikov and others (1973, 1974), and Kafarsky and others (1975) indentified 11 mineralogical halos (table 12A–2). They are distributed among the larger basins of the Shewa, Rawenjab, Ragh, Zamudor, and Darrah-i-Jaway rivers and the smaller basins of the Ghumay, Begaw, Kuf, Chasnud, Golom, Nakhchir Par, and Pilo rivers (fig. 12A–9). The halos vary from as little as 50 km^2 to 840 km^2 in area. The bedrock geology is principally comprised of structurally complex Proterozoic age metamorphic rocks, Paleozoic age sedimentary, volcanosedimentary, and intrusive rocks, and Mesozoic age sedimentary rocks that are intruded by Triassic and Oligocene granitic rocks that are exposed within the structurally complex fault blocks and structural subzones of the Afghanistan-North Pamir and Afghanistan-South Pamir structural regions of Afghanistan (Abdullah and others, 2008). Samples from these halos commonly yield a gold content that ranges from a single color (grain) to as much as 0.43 g/m^3, with the single greatest yield of 6.1 g/m^3 occurring in the headwater area of the Rawenjab, Ragh, and Seh Ab river basins (no. 9, 16/200–IV). This latter locality occurs within a region where the Weka Dur (Vekadur) lode gold deposit and eight lode gold occurrences are located (Abdullah and others, 1970, 2008).

Within the watershed of the middle and upper reaches of the Kokcha River of southern Badakhshan, sampling by Nazarov (1965), Denikayev and others (1973) and Kafarsky and others (1975) identified six halos (table 12A–2). They are distributed among the smaller internal basins of the Sanglech, Shinadi, Mashad, Zardew, Buzurg, and Dehgal rivers (fig. 12A–9).

The largest halo, a 1,400 km^2 tungsten halo that occurs along the length of the Mashad River basin, has an associated gold content that varies from a single color (grain) up to 0.09 g/m^3 among samples (Kafarsky and others, 1975; table12A–2). The remaining halos range from 20 to 290 km^2 in area and, among samples from these halos, the yield varies from a single color and, rarely, to as much as 50 colors of gold. Although the bedrock geology of the southern Badakhshan halos exhibit little to no difference to those of the northern halos, their associated structural regions do differ. In northern Badakhshan, the bedrock geology is associated with subequal parts of the Afghanistan-North Pamir and Afghanistan-South Pamir structural regions; however, in southern Badakhshan it consists of the larger, subequal parts of the Afghanistan-North Pamir and Nuristan-Pamir median mass structural region and a lesser part of the Afghanistan-South Pamir (Abdullah and others, 2008).

Sampling by Kafarsky and others (1975) identified the largest gold halo in western-most Badakhshan Province. It spans the tributary basins and interfluves of the Ab-i-Dawang, Pasha Darrah, and Mucha Darrah rivers which, respectively, lay in the Panj, Kokcha, and Yangi-Kala river watersheds (fig. 12A–9). The regional bedrock geology largely consists of Miocene and Pliocene age conglomerate, sandstone, siltstone and lesser clay that occur within the Kulyab Megasyncline and adjacent Kokcha Graben of the respective North Afghanistan Platform and Afghanistan-North Pamir structural regions (Abdullah and others, 2008). Conglomerates of early Pliocene age, called the Karanak Formation, are identified as a primary source of detrital gold for the Samti and Nuraba commercial placers, the Chah-i-Ab noncommercial placer, and the permissive deposits of the lower Kokcha River (Galchenko and others, 1772, 1974). Out of 67 samples collected, among 42 samples the gold content varied from a single to 10 or more colors and among five samples it varied from 0.02 to 0.2 g/m^3.

Sampling by Nazarov (1965) identified a 300 km^2 halo indicated to occur in a nonspecific location in the Kokcha River basin. The halo is restricted to Archean age metamorphic rocks and Lower Carboniferous age volcanic and sedimentary rocks. These indicated rock types co-occur in numerous areas within the middle and upper reaches of the Kokcha River basin; however, at this time, the precise location of the halo cannot be identified without further information. Out of 104 samples collected, 39 samples exhibited a single color of gold and among seven other samples the gold content varied from 0.04 to 0.50 g/m^3.

12A.12 Takhar and Badakhshan Permissive Areas

One comparatively specific and one nonspecific locality for mineralogical gold halos, as summarized by Abdullah (2008), are described from the Kokcha River watershed by Semionov and others (1967) (table 12A–2). This watershed region not only encompasses southern and western-most Badakhshan but also a portion of north-central Takhar Province. Based on limited geographic information and descriptive bedrock geology, the two halo localities of Semionov and others (1967) are tentatively located along the border area of the provinces (fig. 12A–9).

Table 12A–2. Geographic localities, geology, and gold content of mechanical mineralogical gold haloes of Badakhshan and Takhar Provinces.

[Data are from Abdullah and others, 2008. g/m^3, grams per cubic meter; km^2, square kilometers]

Geographic locality (fig. 12A–9)			Halo area, km^2	Gold content
Province	Principal watershed	Secondary river or river basin		
Northern Badakhshan	Panj River (I)	Darrah-i-Jaway River basin	840	Among 54 of the 115 samples collected for a tungsten halo, the associated gold content varied from a single color up to 0.02 g/m^3.
		Ghumay, Begaw, and Kuf River basins and the mouth of the Shewa River	500	Of 71 samples collected, among 50 samples the gold content varies from a single color to as much as 0.4 g/m^3.
		Lower course of Chasnud and the basin of the Yarkh Rivers	80	Of 35 samples collected, 16 showed a single color of gold and one yielded 0.18 g/m^3.
		Lower course of Shewa River	150	Of 27 samples collected, 21 had showings of gold.
		Zamudor and Rawenjab river basins	300	Of 22 samples collected, all showed a single color of gold.
		Headwater area of the Zamudor and Rawenjab Rivers	130	Among 65 samples collected, the gold content varied from 0.12 to 0.35 g/m^3.
		Middle course of Shewa River	50	Of 17 samples collected, 14 showed a single grain of gold, scheelite, bismuthinite, galena, and cerussite.
		Golom River basin	300	Of 74 samples collected, the gold content of 36 showed single colors and one sample had 0.43 g/m^3.
		Headwater area of the Rawenjab, Ragh, and Seh Ab Rivers	150	Among 20 of the 50 samples collected, the gold content varied from 0.1 to 6.1 g/m^3.
		Middle course of Shewa River	150	Of 32 samples collected, 10 showed a single color of gold.
		Middle course of the Nakhchir Par River and headwaters of the Darya-i-Pilo (Pila) River	230	Of 45 samples collected, 20 showed colors of gold.
Southern Badakhshan	Kokcha River (II)	Sanglech and Shinadi Rivers	115	Of 27 samples collected, 22 showed a single color of gold.
		Zardew River watershed	20	Among four of the seven samples collected, there was as much as 50 colors of gold.
		Darrah-i-Mashad River	1,400	Among 60 of the198 samples collected for a tungsten halo, the associated gold content varies from a single color up to 0.09 g/m^3.
		Jakhan River basin and headwaters of the Bozurg (Buzurg) River	290	Of 64 samples collected, 17 showed a single color of gold.
		Dehgal River basin	100	Of 20 samples collected, six showed a single color of gold.
		Kokcha River basin. Not plotted on figure 12A–9	300	Of 104 samples collected, the gold content of 39 samples exhibited a single color and among seven other samples it varied from 0.04 to 0.50 g/m^3.
Western Badakhshan	Panj (I), Kokcha (II), and Yangi-Kala (III)	Pash Darrah, Mucha Darrah and Ab-i-Dawang river watersheds and interfluves	700	Of 67 samples collect, the gold content among 42 samples varied from a single to 10 or more colors and among five samples it varied from 0.02 to 0.2 g/m^3.
Takhar and western Badakhshan	Kokcha River (II)	Right-hand bank of the Kokcha River and head waters of the Yaftal River	14	Among four samples collected, the gold content varied from ten or more grains.
		Kokcha River valley, right-hand tributary	25	Among five samples collected, the gold content varied from single grains to 0.17 g/m^3.

Sampling by Semionov and others (1967) identified two halos in the Kokcha River basin. The first and smaller, covering a 14 km^2 area, occurs in the region of the right-hand bank of the Kokcha

River and the head waters of the right-hand tributary of the Yaftal River. The bedrock geology is comprised of Pliocene age conglomerate. Among four samples that were taken, the gold content varied from ten or more grains. The second halo, 25 km^2 in area, occurs in the valley of the Kokcha River right-hand tributary. The bedrock geology consists of Pliocene age conglomerate and Lower Carboniferous age plagiogranite. The gold content among five samples varied from single grains to 0.17 g/m^3. To some degree, the locations of these halos within the Kokcha River watershed can be limited by the occurrence of the Pliocene age conglomerate, whose exposures are largely restricted to a 30- to 40-km wide belt along the border of Takhar and Badakhshan Provinces.

12A.13 Conclusion

Recently, the MOM signed a 10-year exploitation and development contract for the Samti and Nooraba deposits. An Afghan company, West Land Trading Company (WLT), won the contract promising to provide more than 300 residents with jobs, invest in local infrastructure, and support the national government with royalties set at 20 percent (Ministry of Mines, 2010). The contract requires WLT to inject more than $40 million (U.S.) into the local economy over that period of time. The contract estimate is that 12,000 kg are within the Samti deposit and 580 kg are within the Nooraba deposit. Progress in the mining economy in Afghanistan shows the importance of these resources for commercial production but also indicates the possibility of a viable artisanal and small-scale mining industry in Takhar and parts of Badakhshan Provinces. Further work is necessary to reevaluate the previously tested and sampled deposits using more technologically advanced methods, including taking advantage of satellite imagery and DTM resource mapping methodologies. Future work may help in determining permissive zones for exploration and exploitation efforts.

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