

Country Update Paper on Pakistan

Sayyed Hossein Shah Bukhari

Mailing address, P. O. Box: 3287 Gulberg Colony, Lahore-54660, Pakistan

E-mail address, sayyedhossein@hotmail.com; hosseinsayyed@gmail.com

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ABSTRACT

Geothermal direct and indirect usage

1. OVERALL ENERGY SCENARIO

World's community of Geothermalists report the advancement in geothermal developments of their respective countries to the IGA sponsored WGCs after each 5 five years' period. These developments are reported within the background of overall energy situation during those five years, but Pakistan's energy situation is a continuity of an energy crisis that goes back, well beyond two decades and cannot be delinked.

Pakistan is a unique country that is very rich in Geothermal & all types of other Renewable Energy Resources plus conventional resources like Hydro, Coal, Oil & Gas; but she is still facing escalating shortages in its energy sector since the last two decades. Till 1980s, Pakistan remained among LICs (Low income Countries) & LDCs (Less Developed Countries), was suddenly burdened with millions of migrated refugees from neighboring Afghanistan due to Soviet Invasion in 1979. Again Pakistan was pushed to face involvement in war in its same neighborhood from a second super-power (US in 2001). Since then, a well-planned long guerilla proxy-war has been waged under a so-called "war-on-terrorism", on its soil, that continues till today. Pakistan is a great country that is constantly facing (with very strong nerves), hostile nations in its East & West since 3.5 decades. A continuous combination of hot & cold wars that is longer than any wars in world history. So in general we do not blame our governments if they cannot develop its abundant rich energy & mineral resources.

The electrical outages of Pakistan began to shape up into a crisis after 2008, when the gap between demand and production widen rapidly. A load-shedding solution system appeared from the Government to manage this crisis. Throughout the five years period, last outgoing "Democratic" government continued to distribute a shrinking power production to the people through this prescription of Load-Shedding. People and Industries were compelled to shift themselves to Generators, burning more and more imported Fossil Fuel. IPPs units also ran over the imported fuel only. Another enemy within the nation was also taking birth and it was the Genie of corruption. National Power Distribution Grid became a favorite target of electrical-thefts by the powerful corrupt mafia under the selfish umbrella of ruling 3-political parties' coalition. Towers of National Electrical Grid remained a special target of foreign terrorist especially in Baluchistan. Till 2008 Pakistan's actual total generation from combined resources (Hydro, Nuclear & Coal) was 19,951 MWe only, while the demand shoot up to near 30,000 MWe. Till 2012, due to financial constraints, not a single effort was made to increase the power production. However, for a sixty five years old ally (Pakistan), finally, US Aid program appeared in 2010-2011 with the funding facilities and many potential Hydro Projects lying in the Ministry of Water & Power's planning shelves wake up to life especially in Khyber Pakhtunkhawa Province.

2. PRESENT OUTPUT OF ELECTRICITY

As mentioned above besides Geothermal Energy, I have tried to present the overall scenario of energy in Pakistan. The present energy production of the country through various resources is shown in the Table 1.

As we can see from table 1 that role of geothermal energy for electricity generation is none in Pakistan. World Bank data collected up to 2010 shows that the country is having an electrification rate of 67 percent only and millions of homes are still without electricity. The country is in dire need of exploiting all its indigenous energy resources.

In this paper I shall discuss the important geothermal resources and areas of Pakistan which are not covered in detail before by this author. As a reminder, I am quoting here just the topics of my earlier papers written on Pakistan's geothermal resources appeared via IGA:

- Paper covering the "shallow resources of Pakistan" written for WGC2005
- Paper in IGA News # 64, covering the "hot springs of Karachi"
- Paper at Bali 2010 covering the comprehensive detail of "Seismo-Tectonic Zones of Pakistan" including the Fault zones of the country as well as updated data of Hot Springs.

3. GEOLOGICAL BACKGROUND OF THE COUNTRY AT GLANCE

Situated in South Asia, Pakistan is geographically overlapped by three huge continental masses i.e. Eurasian & Arabian continental (plates) from North, West & South and Indian sub-continent masses from East. Pakistan Geographical territory is also known as "Intercontinental Collision Belt". Tectonic border-line exists with the following tectonic-geological division:

- Western edge of Austro-Indian Tectonic Plate is passing vertically (south-north) in a zigzag from Pakistani territory thus some parts of Kashmir is across its north-eastern curvature, while some parts of Punjab & Sind Provinces are spread across its eastern sides. (29°05'N, 62°30'E, Latitude & Longitude)

- Baluchistan-FATA-KPK-Hazara-Gilgit-Baltistan Provinces are lying across its West & North Western side. But we can also explain it further by saying that these provinces are overlapped by the Eastern & Southern extension of Eurasian-Arabian Continental Masses {Central influx up to D.G.Khan at 30°05'N, 70°43'E Latitude & Longitude & 36°0'N, 77°0' E of North Eastern influx of Northern influx up-to northern extremes of Biafoo Glacier}.

Similarly very good prospectus of geothermal exploration is available along many sub-tectonic Fault Lines connected with these Arabian-Eurasian & Austro-Indian Tectonic Plates.

Table 1: utilize1-05 (Source: Table format & number: Geo-Heat Centre USA).

TABLE 1. PRESENT AND PLANNED PRODUCTION OF ELECTRICITY																				
	Geothermal			Fossil Fuels			Hydro			Nuclear			Other Renewables						Total	
	Capacity MWe	Gross Prod. MWh/yr	Planned	Capacity MWe	Gross Prod. MWh/yr	Planned	Capacity MWe	Gross Prod. MWh/yr	Planned	Capacity MWe	Gross Prod. MWh/yr	Planned	(Wind)			Solar			Capacity MWe	Gross Prod. MWh/yr
													Capacity MWe	Gross Prod. MWh/yr	Planned	Capacity MWe	Gross Prod. MWh/yr	Planned		
In operation ★ in December 2014	0	0	0	21,593	12,580	★★	52634	6463	1000 Mwe by 2016	2200	462	880 MWe till 2016 & 2200 Mwe by 2020	9700 MW	★★★		143,000 MW	20 MWe nationwide (individually- Govt.)	1000 MWe via a single solar park within 2014	229,127	19,531
Under construction in December 2014																				
Funds committed, but not yet under construction in December 2013-14																				
Total projected use by 2015				21,593	12,580		52634	6463		2200	462		9700	656		143000	20		229,127	19,531
★ All capacities are based on annual estimates ★★ Gross production figures are mentioned here in MWh/Yr ★★★ Source: Figures are combinedly based from government, web and press published material.																				

Pakistan is a four season country and a geological wonderland right from south to north. Three quarter of the Land is comprised of rocks of substantial varieties starting from the coastal belt. In the extremes of North, it has world's highest mountains, World's longest glaciers after North & South Poles and a junction point of three majestic ranges of mountains. It has vast plains and deserts, Lakes & Rivers as well as many springs from normal to hot water. Pakistan's most panoramic mountain Nanga Parbat's northern Gneisses is comprised of basaltic, andesitic, volcanic and volcano-sedimentary formations and here lies a wet geothermal source (also indicated earlier in my paper written for WGC2010 at Bali). From this rare Wet Geothermal source, Fumaroles is emitting out from deep source of 3 to 6 Km underground magmatic & granitic hot rocks [1]. This pure energy is simply getting lost in the air and keeping the Nanga Parbat almost wrapped year around in dense clouds. It is a ready-made source to generate power, but just getting wasted. Only a power house is required to be installed here, though the job is a challenging one.

4. LOWER ENTHALPY RESOURCES OVERVIEW

Hot-Springs waters are continuously being wasted on country-wide basis, and this writer has only and only one comment on this situation, i.e. "this improper hot water wastage is equivalent to the wastage of fuel oil". Overall usage of hot-springs water, if any, is being done for bathing purpose only by the local population. 90% hot water of these springs is just drained out and ends up into nearby rivers or sewages. Two springs of Manghopir & Drig Road Karachi are now within the city and being utilized only for Spa (bathing). A Crocodile Farm Pool, however, receives this naturally heated spring water from Manghopir spring.

After 2010, geothermal heating/cooling units in two residential houses of Islamabad and Lahore have been personally visited and verified by this author.

In this paper, I have tried to cover the Volcanic and Granitic Regions of Pakistan that are most suitable for exploring HDR based geothermal resources. After completion of Australian Geothermal Project over their deep Granites, it is worth mentioning that Recent advancement and research on the presence of certain ratio of Helium Gas (3He 4He) Traces can determine the heat intensity of underlying rocks and has ignited a renewed world-wide interest in Granite Rocks. With this new research a lengthy and painstaking process of testing the under-lying Sedimentary & Granite rocks will shorten. A geothermal source can now be detected as positive or negative from the surface, by testing the ratio of helium isotopes and identifying the areas having high concentration of geothermal heat.

Geothermal & other Renewable Resources Prospects on the Coastal Belt of Pakistan:

After the devastating Earthquake in Pakistan during 2005 along the Fault Lines of Azad Kashmir, further picture of seismic activities are emerging on our Coastal Belt in South along the Arabian Plates.

Two earthquakes of various intensity occurred nearby the 1000 KM long Great Chaman Fault in its southern orientation. This area is situated on our coastal belt's surrounding vicinities where the Great Chaman Fault submerges down in the Arabian Sea.

Chaman Fault and other faults of the area have now become active in the south, and most of the seismic activities are continuously taking place within the southern faults surroundings. High pressured Sub-Sea hot gases are being released within the sea water from the ridges of all these group of fault lines.

According to officials of National Institute of Oceanography who keep eye on our coastal belt; “It’s common to see arising bubbles at the surface of seawater along this coastal belt.”

We can now predict that over the land it is most plausible area for geothermal exploration point of view.

Table 2: utilize3-06: (Table format & number Source: Geo-Heat Centre USA).

**TABLE 3. UTILIZATION OF GEO THERMAL ENERGY FOR DIRECT HEAT
AS OF 31 DECEMBER 2014 (other than heat pumps)**

I = Industrial process heat
C = Air conditioning (cooling)
A = Agricultural drying (grain, fruit, vegetables)
F = Fish farming
K = Animal farming
S = Snow melting

H = Individual space heating (other than heat pumps)
D = District heating (other than heat pumps)
B = Bathing and swimming (including balneology)
G = Greenhouse and soil heating
O = Other (please specify by footnote)

Enthalpy information is given only if there is steam or two-phase flow

Capacity (MWt) = Max. flow rate (kg/s) [inlet temp. (°C) - outlet temp. (°C)] × 0.004184 (MW = 10⁶ W)
or = Max. flow rate (kg/s) [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] × 0.001

Energy use (TJ/yr) = Ave. flow rate (kg/s) × [inlet temp. (°C) - outlet temp. (°C)] × 0.1319 (TJ = 10¹² J)
or = Ave. flow rate (kg/s) × [inlet enthalpy (kJ/kg) - outlet enthalpy (kJ/kg)] × 0.03154

Capacity factor = [Annual Energy Use (TJ/yr)/Capacity (MWt)] × 0.03171
Note: the capacity factor must be less than or equal to 1.00 and is usually less, since projects do not operate at 100% of capacity all year.

Note: please report all numbers to three significant figures.

Spring's Locality ★	Type ¹⁾	Maximum Utilization				Capacity ²⁾ (MWt)	Annual Utilization			
		Flow Rate (kg/s)	Reservoir Temperature (°F)		Enthalpy ²⁾ (kJ/kg)		Ave. Flow (kg/s)	Energy ⁴⁾ (TJ/yr)	Capacity Factor ⁵⁾	
			Inlet	Outlet	Inlet	Outlet				
1 Murtazabad Springs, Hunza Region ★★	B	20	240	237	92	90	0.04	1.2616	0.0795817	0.06308841
2 Budelas Valley Springs, Hunza Region ★★★	B	03	161	159	46	43	0.009	0.28386	0.0268588	0.09463262
3 Dasu Springs, Kohistan Region ★★★★★	B	22	204	200	71	68	0.066	2.08164	0.1969648	0.09463262
4 Mushkin Spring, Astor River	B	01	92	90	57	56	0.001	0.03154	0.0009948	0.03154421
5 Tatta Pani, Sakardu Region	B	26	205	200	83	81	0.052	1.64008	0.1034562	0.06308841
6 Sassi, Sakardu Region	B	23	202	200	54	52	0.046	1.45084	0.091519	0.06308841
7 Karsaz Spring, Karachi	B	05			45	40	0.025	0.7885	0.1243465	0.15772104
8 Manghopir Spring, Karachi	K, B	25			55	50	0.125	3.9425	0.6217323	0.15772104
9 Kharan Region & Kohe-Sultan Springs ★★★★★	B	25	170	150	32	25	0.175	5.5195	1.2185952	0.22080945
TOTAL		141	1274	1236	535	505	0.539	17.0001	2.4640493	0.94632622

★ Source: Geological Survey of Pakistan

★ Besides the 9 Regions mentioned here, there are more spots where single or multiple geothermal springs exist. Thermal gradient springs with no specific available data are taken into account here. Geological Survey has issued a list of 12 Regions investigated (Ref. Paper of Mr. Sikandar Bakht for WGC 2000)

Among the rare geo-pressured Dry Steam Geysers of world, one was discovered in the foothills of Nanga Parbat during September, 1996 by the team of New Zealand & US explorers. By author's point of view, it is most exciting and extraordinary news with reference to geothermal resources of Pakistan.

★★ Total Five Nos. of geothermal springs on western Hunza valley.

★★★ Total Three Nos. of geothermal springs on both banks of Budelas River within 7-12 Km distance

★★★★ Total Five Nos. of geothermal springs in Sakardu Region.

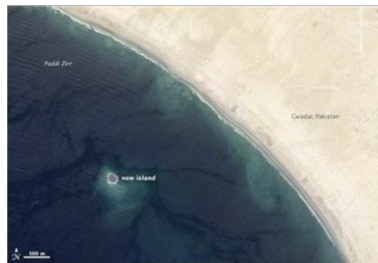
★★★★★ Springs of these remote areas are considered most perspective because these regions are situated in the volcanic belt. Data available from the old British Record subsequently confirmed by Geological Survey of Pakistan (Reference Paper of Bakht for WGC 2000). Enthalpy of Kohe-Sultan Spring ranges from 25°C to 32°C

Since 2010, following events occurred in the Southern Pakistan:

- Along the Chaman Fault's over-the-land and sub-sea-zones at the coast of Baluchistan, an earthquake occurred in September 2013 and an island appeared in the sea near Malan island (island itself is 3 KM away off-shore). However, newly appeared island vanished in the sea after few months.
- On 24th of September 2014 an earthquake at Richter scale of 8.7 occurred at Avaran (Baluchistan) and heavy devastations occurred affecting vast areas of Baluchistan & Sind.
- After the earthquake, a new island appeared One & Half Nautical Miles away in the sea off Gawadar port. The small island's size is 50 Meters long, 20m wide and 10m above the sea level. A team of Geologists of National Institute of Oceanography (NIO) visited island and found that methane gas was emitting from various spots.
- Another two tiny islands also appeared in the sea few miles from Bidok and Bal villages along the coast of Ormara and Pasni.



(Image # 01)



(Image # 02)



(Image # 03) source: Dawn Newspaper

Figure 1: Image 01, 02, 03. Photos Source: <http://earthquake-report.com/2010/11/27/deadly-earthquakes-of-november-27-pakistan-and-iran-2x/> & newspaper Daily Dawn, Pakistan. (On Sept. 26, the Advanced Land Imager on NASA's Earth Observing-1 satellite captured above images of Pakistan's new island).

Such islands have appeared in the past and collapsed back in the sea after few months.

It has happened before when from beneath the sea, Malan Island (it was also named Zalzala Island) itself rose up the surface overnight after earthquake during March 1999, and then within a year receded back to sea. In 2010 it re-appeared from the sea at the same place and still exists.

For a mismanaged energy deficient Pakistan (MEDP), this seismically active region is an open invitation to exploit all its energy resources from geothermal energy to extensive reserves of frozen methane & oil, off the coast of Baluchistan.

On the same coastal belt if we travel towards east, oil rich sedimentary Shale Rocks Concentration is present, holding the huge deposits of oil and gas. World has fewer shale rocks concentrations those can be counted on fingers (please see the map below) and Pakistan is ranked No.9, by holding such reserves that are technically recoverable shale oil resources.

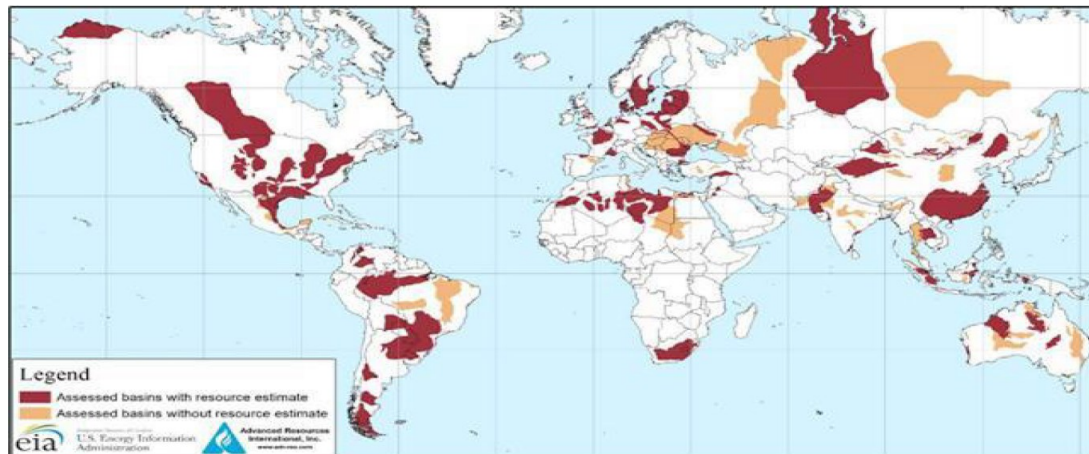


Figure 2: (Image # 04) Pakistan position of shale rocks on EIA world map (by Energy Institute of America).

Horizontal drilling and hydraulic fracturing methods are used to drill Shale Rocks Resources, just similar to Geothermal Resources are explored. These techniques are proven and have been applied in the Barnett Shale of Texas by the US drilling experts. The Gas Reserves in Pakistan shale rocks are said to be 586 trillion cubic feet, while estimated shale oil reserves touches 227 billion barrels. Even if 10% of these shale reserves could be extracted, this country can become self-sufficient in Gas & Oil. Intelligentsia in Pakistan is simply astonished on its leaders and ruling bureaucracy that why they ignore these indigenous resources and only talk about importing gas through pipe lines from thousands of kilometers away from Turkmenistan and making the country permanently dependent on imported oil.

5. VOLCANIC AREAS OF PAKISTAN

After looking at the coastal belt Energy Resources, let us have a look over volcanoes of Pakistan. Volcanic Regions are considered highly favorite spots to explore the Geothermal Energy. Pakistan's volcanic regions are entirely located in Baluchistan. Here world highest known total mud volcanoes are located and their number reaches to eighteen (18).



Figure 3: [Image 05] source Website: pakistaniat.com, Mud Eruption.

Following regions have been marked as volcanic regions [2]:

NEZA-E-SULTAN: Situated in the Chaghai Magmatic belt of Pleistocene Era. It is an extinct spear shaped volcano of Koh-e-Sultan mountains with visible magma chamber. Here we have double blessing i.e., a strato-volcanoe and a high enthalpy hot spring.

TOOR-E-ZAWAR: An extinct volcanic mountain with a group of closely spaced fissure vents between the Bibai and Gogai Thrust Faults in the Ziarat Region at Wham village. These faults are also known as tectonically active region and Toor-e-Zawar is situated between these two faults.

HINGOL MUD VOLCANOES OF MAKRAK BELT: These peaks are covered with mud from surrounding to the top, as the volcanoes spewing mud only. Fantastic landscape has been created around. A little distance away a mildly hot spring is also created.

CHANDRAGUP MUD VOLCANO: “Volcanoe of Moon” is situated in a series of accumulation of volcanoes covered with thick layers of hardened mud. Chandragup itself is having a height of 300 feet from base to top and is highest and most magnificent mud volcanoes of Baluchistan.



[Image 06]



[Image 07]



[Image 08]

Figure 4: Source: Website: pakistaniat.com.

ZIARAT VOLCANIC REGION: Stretched between Longitude 67°15' to 67°45' and Latitude 30°15' to 30°45' is holding Igneous Rocks Formation as a result of lateral & vertical molten lava flow. Area has been marked and mapped with high ratio of aeromagnetic anomaly.

CHAGHAI ARC REGION: A huge under-populated (mostly un-manned) region and magmatic belt. Neza-e-Sultan is also situated here. Entire region is well suitable for geothermal developments. The arc shaped region is composed of Igneous & Granite rocks. Pakistan's atomic blasts also took place here.

Recent Volcanic Eruptions Events: At Toor-e-Zawar Preceded by earthquake, minor eruptions occurred during January 27th to 29th, 2010. However eruption of Gases and flow of basaltic material was of minor nature. Again In January 27th, 2011 similar nature of activities took place at some distance away from the original vent.

Even with these minor eruptions, Toor-e-Zawar has now enlisted itself among the active volcanoes of world.

Besides the above, there are semi-Volcanic regions in Baluchistan i.e.

- Kharan-Panjgur tectonic depression with Aeromagnetic Anomalies.
- Kalat Fault Zone.

6. CONCENTRATION OF GRANITE ROCKS

In stocks and batholiths; buried within depth as well as exposed on continental earth with variations; Granite Rocks are present on our entire planet and are among the hardest rocks of universe. Composed of basic minerals such as Quartz & Feldspar, Granite Rocks are best source of heat radiation, and most suitable and reliable to exploit HDR (Hot Dry Rocks) based geothermal resources. Heat capabilities of Granites are further enhanced if these rocks are holding uranium or thorium. Though not necessarily, but these two ores are mostly found in Granites Rocks in different ratio i.e. uranium from 1 to 20 ppm (parts per million) while thorium is in higher ratios, and keep releasing continuous heat to the mother Granite.

Like other resources Pakistan is lucky to have all types of Granites (A, I, H, M, S) in her territory. Except for S & H type, most Granite types originates or solidified from igneous rocks and can shortly be understood under following classification:

A type: Are directly formed over the volcanic activity (also a special variety coming out of I type).

I type: This type is formed through protolith of igneous rocks.

S type: This type is formed of protolith of Sedimentary formation.

M type: Are formed under crystallizing magma (considered rare in quantity than other types).

H type: Are Hybrid type formed by partially melting of Old igneous rocks.

A, I & H types are found in Baluchistan, while M types are mostly concentrated in Northern areas; and S-type are found in south with high concentration of uranium and thorium.

Besides the Geologists of GSP (Geological Survey of Pakistan), Peshawar University's Geologists have also contributed a valuable research work around Nowshera Reef & Northern areas [3]. Similarly Geologists of University of Sind in collaboration with Atomic Energy Commission have performed a valuable work on Nagarparker Granites. [2] Pakistan has brilliant Geologists who have done exploratory and Research work individually and with collaboration of foreign geological researchers.

Blocks and Blocks of huge deposits of M-type upper mantle Granite Rocks are available in Pakistan, but these are being exploited for construction purpose only. By construction point of view beautiful varieties are available in Black, Pink, Grey, Green, Gold, Yellow, White, Red colors.

An estimated data of Four thousand billion tons of upper mantle Granite deposits have been estimated in Northern Areas alone by construction point of view only. The prominent locations are Gilgit, Dir, Chitral, Swabi, Kohistan, Mansehra, Malakand & Swat in the northern Pakistan.

In south Nagarparker (Sind) and Chaghai in Baluchistan are so far the best known sources of Granite in the country.

Concentration of Granites in Pakistan can be generalized as following.

6.1 Southern Concentration

Situated at 400 km to the southeast of Karachi located at 24° 21' 17"N and 70° 45' 15" E., the Pink & Grey colored Granites have gradually exposed over the border town of Nagarparker. The area is an igneous magmatic complex and over the land a beautiful combination of Sand and Granite Rocks in the Desert of Thar. However, in general Granites deposits are gradually stretched between Indus Basin to our border town of Nagarparker between 69°-0' to 70°-46' Longitude. Nagarparker granites are most perspective site to explore the HDR geothermal resources, as there is a proven presence of thorium & uranium metals within these rocks and making these Granites a continuous source of high thermal conduction, ideal for geothermal extraction. Here the mean values for uranium and thorium in 178 samples collected from the granitic exposures of the area were found 3.4 and 15.4 ppm respectively [2]. Isotopes of Thorium-232 and Uranium-238 are the prime cause of helium gas generation. The area of Nagarparker is surrounded by the marshy Run of Kuch area (an extension of River Indus, and extended Sea Delta). The town of Nagarparker is situated in the foothills of exposed Granite Rocks. There are two small lakes of water from the underground source that is a solid proof of existence of underground hydrothermal system. Therefore, chances of reaching HAS (Hot Sedimentary Aquifer) are very strong and cannot be ignored, thus making this area highly suitable for developing geothermal energy.

Nagarparker Granites and its adjacent areas are a triple benefits to the country, where three types of wells (Geothermal, Oil & Gas) can be found and co-exist, supporting each other. As mentioned above, where there is Uranium and Thorium in Granite Rocks, there will definitely be Helium Gas. Helium Gas itself is most precious and most expensive gas, because naturally it is available in very limited quantity among the reservoirs of natural gas. I have used the word precious in this sense that there are few places on earth where granite rocks, uranium, thorium, helium exist all together, and Nagarparker with its neighboring shale rocks is one of those remarkable rare places on Earth. We should now wake up to protect these precious natural assets, and take benefits of these God blessed areas to benefit our nation.

6.2 Northern Concentration

Massive investigation has been done by both foreign and local geologists on the huge deposits of Granites, present in Western Korakorum, Kohistan. Baltoro & Hunza Granites are of Miocene age; Bhasha valley is also holding granitic rocks deposits. As mentioned above Gilgit, Dir, Chitral, Swabi, Kohistan, Mansehra, Malakand & Swat areas are holding concentrations and clusters of Granite rocks [3].

7. CONCLUSION

From year 2000 till 2011 this writer remained a solo voice on Geothermal (with a proof of written campaign in national press for geothermal awareness), asking the government to exploit the geothermal resources of Pakistan or at least recognize it as a viable energy source. Such recognition at least may pave the way for the Energy Planners in the Ministry of Power to start the basic work on geothermal resources.

14 precious years have been lost since I started advocacy on Geothermal Energy in Pakistan. The cost of geothermal development from those cheap days to present days has gone up several folds. I don't know who will be answerable for these losses. In 2011, on a business forum, I met a former Power Minister on a business forum, but to my utter disappointment, he was perhaps strictly briefed that it's a negligible source of energy. His short and arrogant remarks came: "Solar, Geothermal and all renewable are just a sweet dish." So, in the wake of failure of my long campaign within government circles, I decided to make it a public movement and raised my voice at every public forum. I distributed my published work to anyone who showed interest in Renewable Energy Resources and explaining him in particular about geothermal energy resources of Pakistan. Though now-a-days people here are skeptic about everything, but I am pleased to see that at least in my own city of Lahore, many people can be found supporting geothermal as a viable source of energy, and my 100 pages small book (though now outdated) with basic knowledge on Geothermal is still working to bring awareness for my countrymen.

TABLES FORMAT SOURCE: All Table formats used in this paper are designed in blank and provided by: Geo-Heat Centre USA.

PHOTOGRAPHS SOURC & CREDIT

Page: 4, Image 01 & 02 [Photos Source: <http://earthquake-report.com/2010/11/27/deadly-earthquakes-of-november-27-pakistan-and-iran-2x/> & Advanced Land Imager on NASA's Earth Observing-1 satellite captured above images of Pakistan's new island.

Image 03 source: newspaper Daily Dawn, Pakistan.

Page: 4, Image 04 source: www.eia.gov/analysis/studies/worldshalegas/

Page: 5, Image 05, 06, 07, 08 source: Website: pakistaniat.com.

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