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Partitioned Zone Onshore 3D Seismic Survey Challenges and Best Practices*

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Abstract

Wafra Joint Operation (WJO), a joint venture of Kuwait Gulf Oil Company (KGO) of the State of Kuwait, and Saudi Arabian Chevron (SAC) of the Kingdom of Saudi Arabia, recently completed the Onshore 3D seismic survey in the Partitioned Zone (PZ) by contracting WesternGeco 3302 crew equipped with the UniQ seismic data acquisition system, covering approximately 4600km² (5346 km² including the zippers). The acquisition started in 2014 with the mobilization of the field crew in such a way that the work should not be hampered due to seasonal activities and efforts should be maximized to attain a level project execution above the teething problems.

A project of this magnitude needed strategic planning and innovative best practices to deal with the challenges without affecting the harmony of the locals and by maintaining stringent safety norms and data quality control. Hence, the following activities (Best Practices) were planned to deal with the challenges faced.

- Red Passes automation for Seismic Crew through Bar Coding and data interface.
- UXO, Mines and ERW clearance from field using a combination of armored vehicles and dog squads for mine clearance in open desert and confined areas.
- SIMOPS in oil field, 4th refinery and Khiran Resort for simultaneous activities and safety.
- Safety initiatives for night SHD operation.
- Drilling practices with full PPE and safety norms.
- PPV survey and meetings with Civic Authorities.
- Stake holder's engagement and road show.
- Posters, Banners and Roadshow of vibrators for demonstration and public awareness.

This was one of the largest onshore seismic operation in the world and needed innovative and a proactive approach to deal with the challenging environments encountered in the PZ. This project was completed ahead of schedule due to the best practices introduced and more importantly the people willing to adopt them.

Introduction

The entire Partition Zone was divided into two blocks such as Exploration (PZ 3D East) and development (PZ 3D West) based on the presence of proven oil fields and density of wells as well as production profile. Further, for seismic data acquisition purpose, the area had been split into three blocks, block 1, 2 and 3 with a nominal width of 30.6 km. The blocks had a 6km combined source and receiver overlap (zippers) to maintain the fold when joining the data sets together at the processing stage. Partition Zone is split into north and south blocks ([Figure 1](#)).

Wafra Joint Operations (WJO) operates across both the blocks and supervises the seismic data acquisition activities in the whole PZ. [Figure 2](#) shows the different acquisition blocks and explains the complexity of the 3D onshore operation by making base camp in the PZ northern side for operational purposes. These three more or less NS oriented blocks of the order of dimensions shown in [Table 1](#) were covered in the same sequence and is shown in the [Figure 3](#) and acquisition was planned from the southern part of Block 1.

Since the southern part of block 3 and some of the southern part of block 2 are covered with Sabkha and wet patches inaccessible by the conventional Vibroseis Seismic Source, it was planned to deploy the Shot Hole Drilling Rigs and using explosives as source in addition to Vibroseis. As the shot holes could not be preloaded with explosives the area had to be drilled and cased in advance, which made the operational more challenging and complex in nature. If we focus over the challenges in the operational areas as shown in [Figure 4](#), there are over two dozen areas that needed special strategies and data acquisition planning to cover the area in best possible way by maintaining the safety norms and data quality at the optimum cost. Hence, PZ was further prioritized for operational exigencies as per the [Figure 5](#) and separate plan was made for each area.

Project Planning

A project of this magnitude needed strategic planning and innovate best practices to deal with the challenges without affecting the harmony of the locals and by maintaining stringent safety norms and data quality control. Hence, following activities were planned to deal with the challenges. [Figure 6](#) shows the most complicated part of work. This was the most challenging part of the operation to begin with and makes it possible to cross over into the southern PZ on daily basis to support the field crew from the base camp as well as fly camp. Special permission was granted to the crew for crossing into the southern PZ through innovative Red Pass system and accessing the data through Bar Coding which is a fairly time saving affair, this process was admired by the officials and WJO which they implemented to all employees and contractors later. A dedicated personal for supporting the field crew was deployed along with the security personnel to deal with technical issues and smoothen the process. Though the operation was done in 24x7 mode, free access into the southern PZ block was restricted to field crew and shift personnel only. Securing access into the southern PZ block on extended hours was the first and very important part of the north-south cross-block operation, which without this, the project would not have been a reality and the rest of the challenges were not so significant in front of this.

Operational Strategy and Challenges

The project was started in 2014 with mobilization of the field crew in such a way that the work should not be hampered due to seasonal activities and efforts should be maximized to attain a level of project execution above the teething problems. A macro map of operational sequences is shown in [Figure 7](#) however many hidden processes are not reflected due to classified nature of data.

Since the operational area, particularly on the northern PZ is affected by the presence of Mine Fields, UXO and other ERW, it was first priority to detect and remove these deadly articles from the potential seismic profiles with enough clearance to work along the field. Some of the potential thrust area is shown in [Figure 8](#).

It was the first and foremost priority to clean the area for the surveyors to provide GPS points for the seismic plans to be transferred to the ground and deployment of the crew for ground electronics and cable laying out activities. It should be noted here that seismic geometry was designed to have 57600 live channels per shot which was really a challenge at the start of the work as it required over a month to make the line stable for such mammoth spread with less than 3% bad traces on record as per contractual obligations and maintaining the data quality of desired level. Though the challenges and negotiation in PZ are not new things, the sheer size of this project made it fairly challenging as the operation was planned for entire PZ running across the northern and southern PZ blocks with 24x7 operational and live crew consists of over 25 nationalities. Hence, following areas were always focused based on the logistics, operational and technical point of view and is reflected in [Figure 5](#). Following illustration ([Figure 9](#)) shows the challenges and plan of action of the WJO and the Crew in a synergic way and the best practices adapted to negotiate with them. These challenges were dealt with some of the best practices and through innovative ideas.

Best Practices Adapted to Deal with Challenges in the Operational Area

Mine Clearance and UXO redressal

Presence of a minefield, as shown in [Figure 8](#), was one of the major concerns for all the stakeholders as it was one of the biggest threats to the operation and warranted special attention. Hence, specially designed armored vehicle as shown in [Figure 10](#) was deployed for detecting and removal of mines in the open desert areas along the seismic receiver and shot lines as well as nearby areas. These vehicles were imported in the country after integrated efforts and approval for the cause of eliminating the threat not only for the technical work but also for the people camping in the open desert areas. Since these vehicles needed clear ground area for their deployment, which was not feasible. In the congested areas such as Farms and Oil field, a separate Dog Squad was deployed ([Figure 11](#) and [Figure 12](#)) for sniffing out the mines and other ERW in the area.

There were no mines found after the operations but it should be worth noting that the moving sand and weather changes make these mines exposed on the surface posing real threat to all roaming around desert for daily work. In addition to this, UXO detection crew was deployed with the survey team, which scanned the areas ahead of operation and removed over 80 numbers of UXO from the PZ.

Simultaneous Operations (SIMOPS)

Wafra joint operation is situated in the heart of oil field and seismic operations was planned across the PZ crisscrossing the pipelines, Sub-Centers, Gathering Stations and many more oil installations. As all the activities of various service providers and contractors were supposed to be done simultaneously without compromising the safety and production modes, a robust SIMOPS plan was executed successfully. Each shift change was planned and had the work permit to execute the work in the best possible way without loss of man-hours. Similar type of efforts were done for Al-Khafji Operations, Fourth Refinery, SAC premises, Al-Khiran construction area and New cities in Northern and Eastern Part of the PZ, power plant and coastal areas. This resulted in time saving and avoiding any unpleasant incident in the operational area.

Peak Particle Velocity (PPV) Survey

Present seismic operation was using Vibrator as energy source in open desert and dry areas while Explosive was used in wet Sabkhas and fringe areas of southern part of PZ. Since these energy sources generate significant amount of energy, which may damage the manmade features if not taken care, hence PPV studies were carried out across these areas to plan and place the adequate energy source and avoid any damage to buildings and / or other facilities. Six Hundred and Sixty Six PPV surveys were conducted across the PZ and data analyzed and used for best deployment of energy sources in the area.

Use of Specially designed Drill Rigs and Vehicles in Sabkhas

Southeastern part of the PZ is inundated with the Sabkhas, tidal water and deceptive near surface features which demanded special type of rigs and vehicles to opt for safe operation. These vehicles and special rigs were designed for this project and were imported into the country and deployed across the operating area for shot hole drilling purposes and shifting of men, machine and material onsite ([Figure 13](#)) shows special machines. Despite of these efforts, challenges of wet zones were so grave that at many places heavy vehicles were stuck and later retrieved after marathon efforts ([Figure 14](#)).

Stakeholder's Engagement and Road Show

Poster and Banners were displayed across the partition zone and live demo was done at the common areas and market places to educate people on the importance of the work as well as safety features. Pamphlets in Arabic, English and Hindi were distributed among general public and desert campers for information interchange. [Figure 15](#) shows the public displays in the PZ area including live demo of Vibrators in Wafra Farm and open desert. Also, SMS text notification message were sent to the community.

Training, Learning and Development Processes

This was the unique opportunity for the region to see and feel one of the largest onshore 3D seismic using vibrator and explosive sources for data acquisition. The complete cycle of seismic operation was described to the trainees, officials of the KGOC, SAC, WJO, MEIM, Corporate board, and normal public through different interactive modes including presentations, discussions, road show, town hall program, print and digital media, live visits to the base camp, field camp, operational areas, vibroseis and explosive operations, mines, UXO clearing and dog

show. The whole gamut of seismic data acquisition, field processing and quality control was converted in different training capsules and nearly all the geoscientists and officials of Saudi Arabian Chevron and Kuwait Gulf Oil Company were briefed with live field training schedules.

[Figure 16](#) shows the live demo session in the field.

Conclusion

This was one of the biggest seismic operations in the world and needed innovative and proactive approach to deal with the challenging environment of the Partition Zone. This project started on July 29, 2014 and completed on May 18, 2016, well ahead of schedule because of best practices adapted and synergy in the various components of the operations. This project can also be seen as the learning platform for many of the young geoscientist, which is a priceless experience for them and good for the all.

Acknowledgement

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Figure 1. Partition Zone.

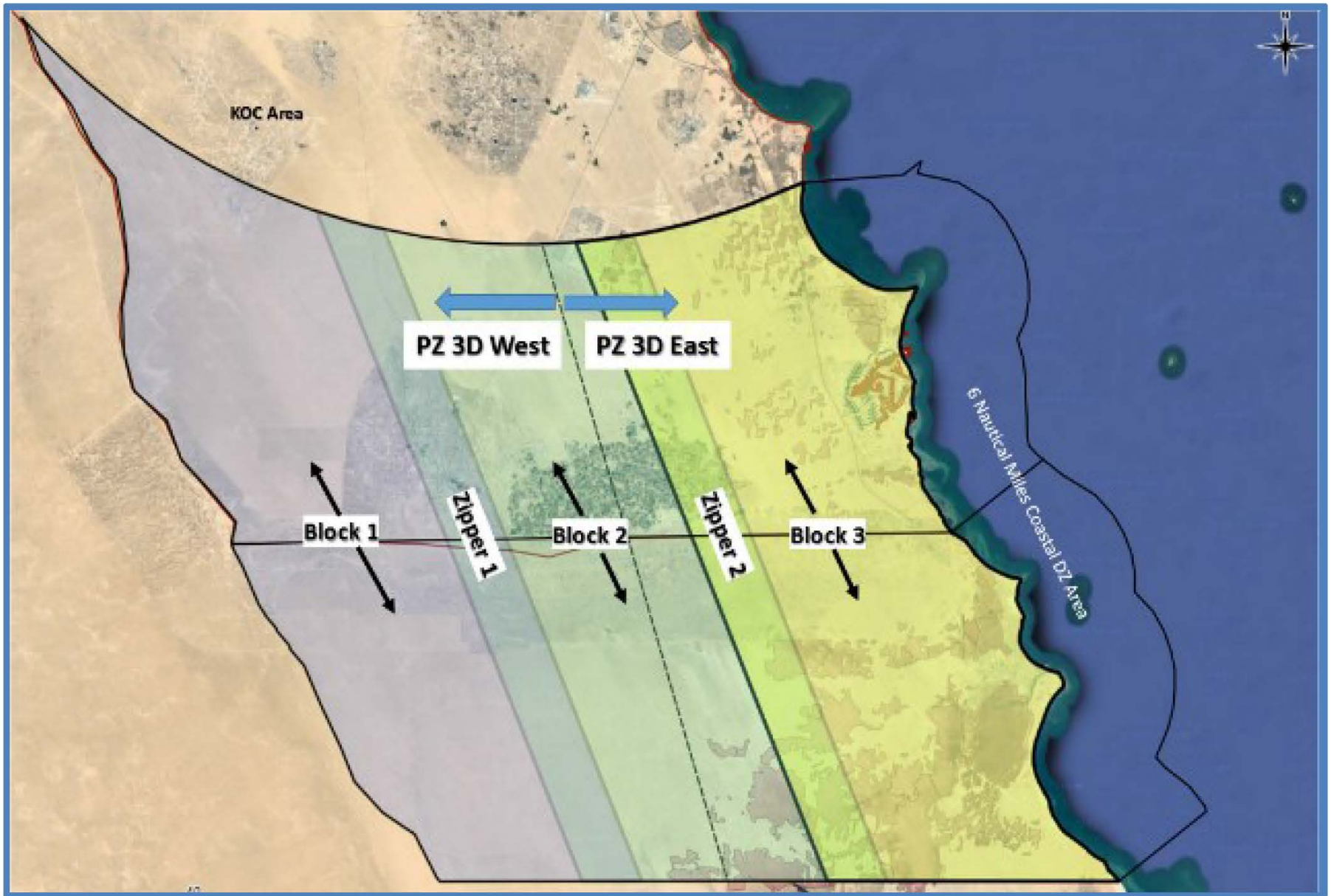


Figure 2. Partition Zone showing different acquisition blocks.

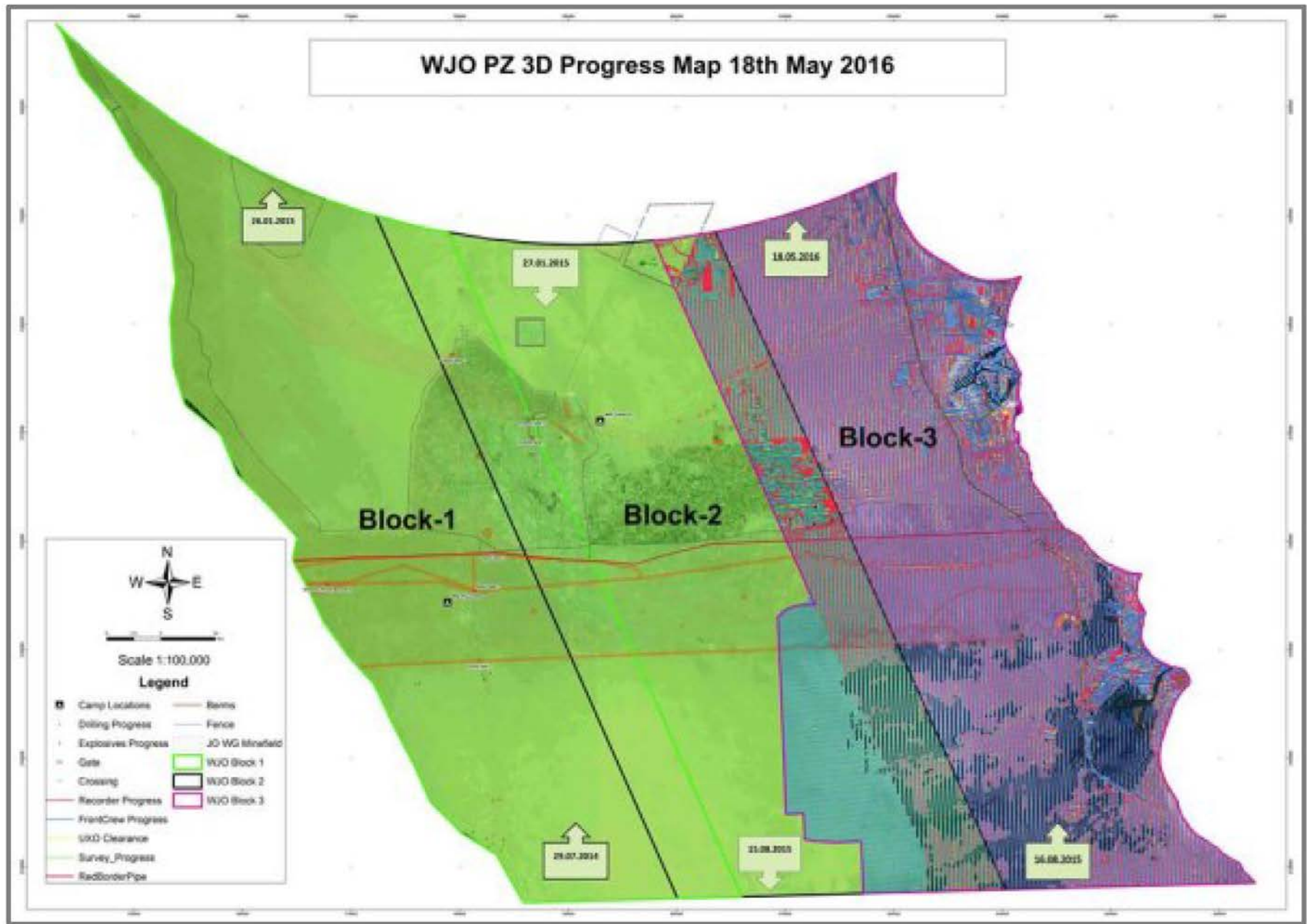


Figure 3. Partition Zone showing data acquisition sequence.

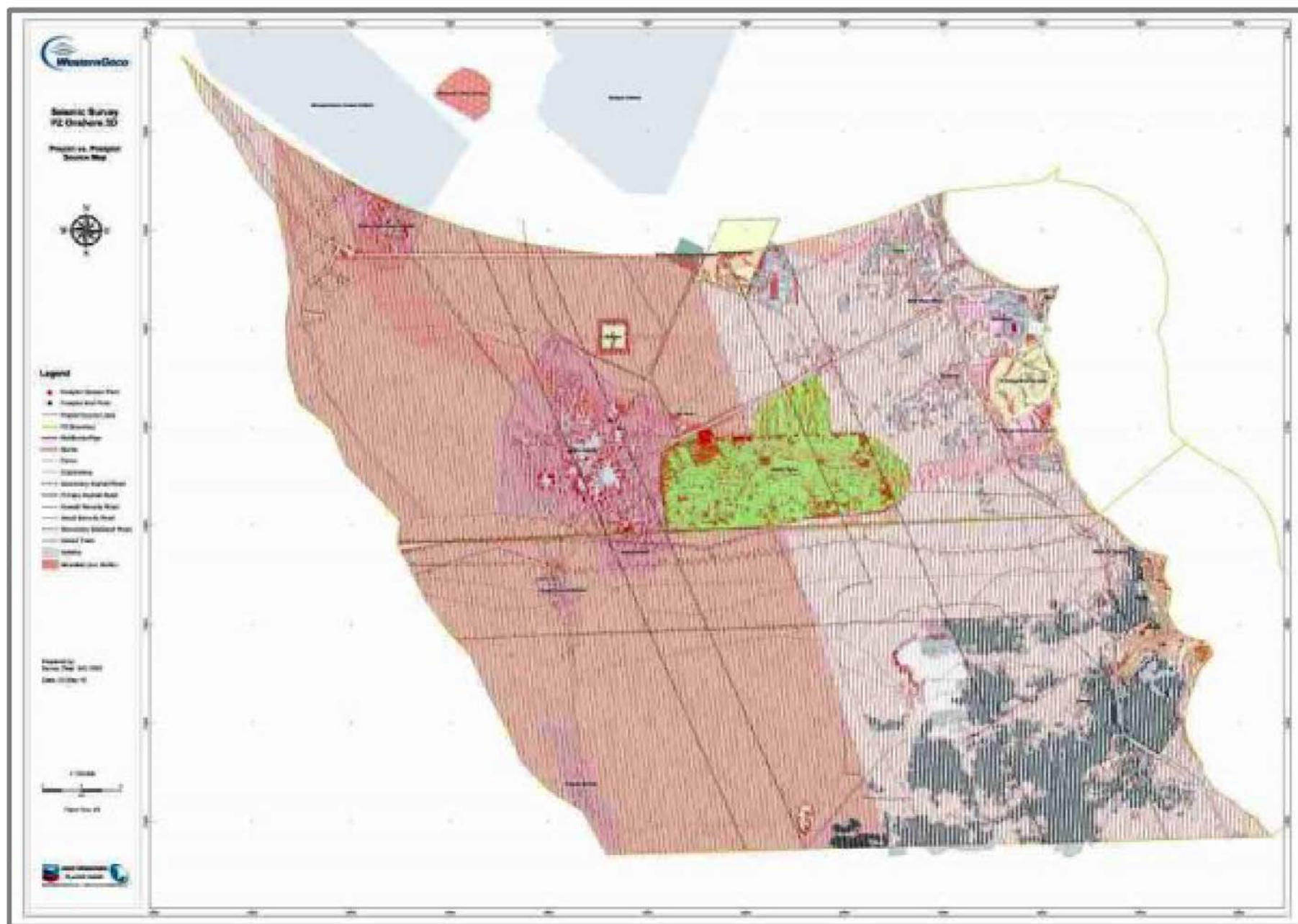


Figure 4. Different challenges present in the area of operations.

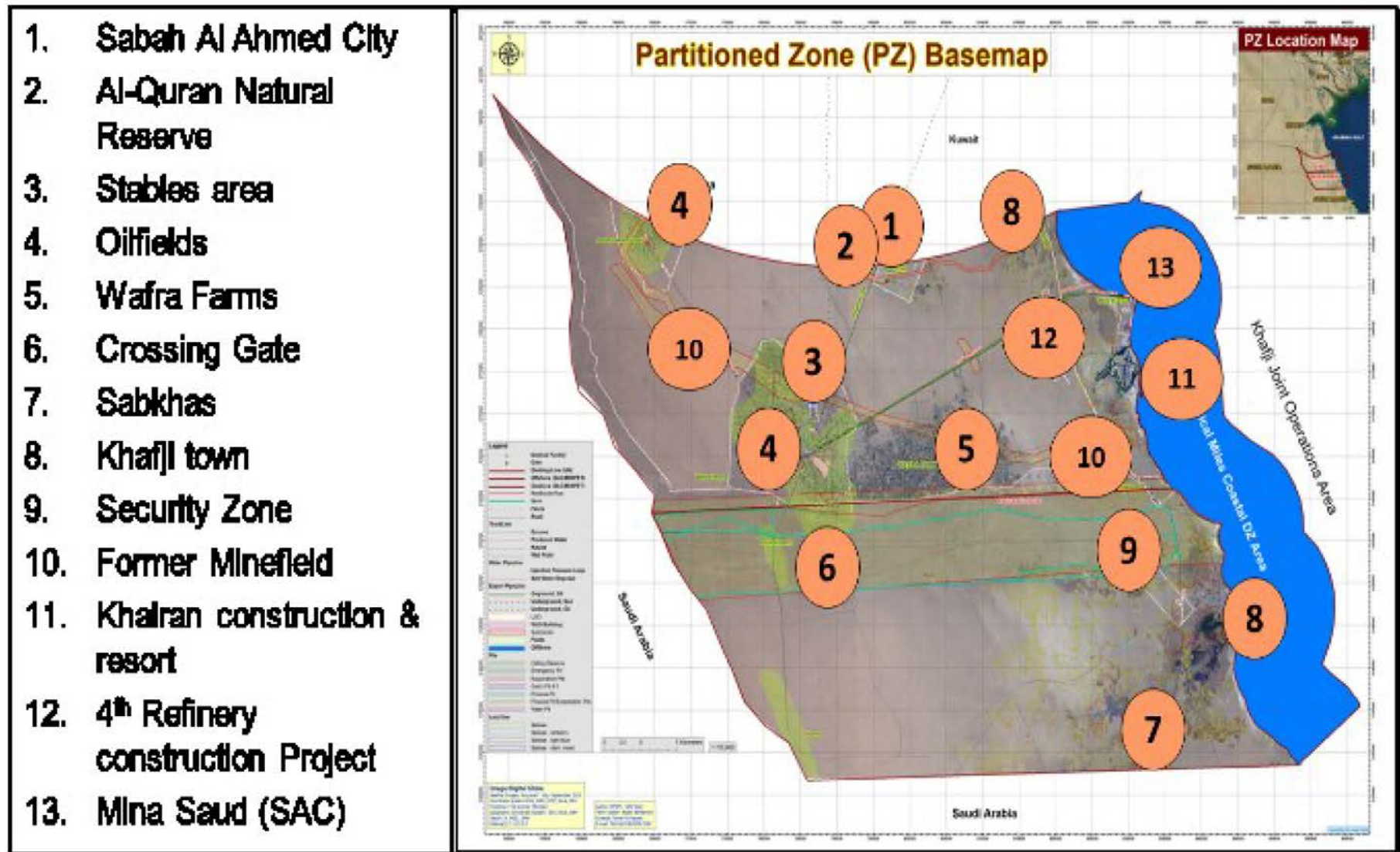


Figure 5. Challenges across the PZ operational area.

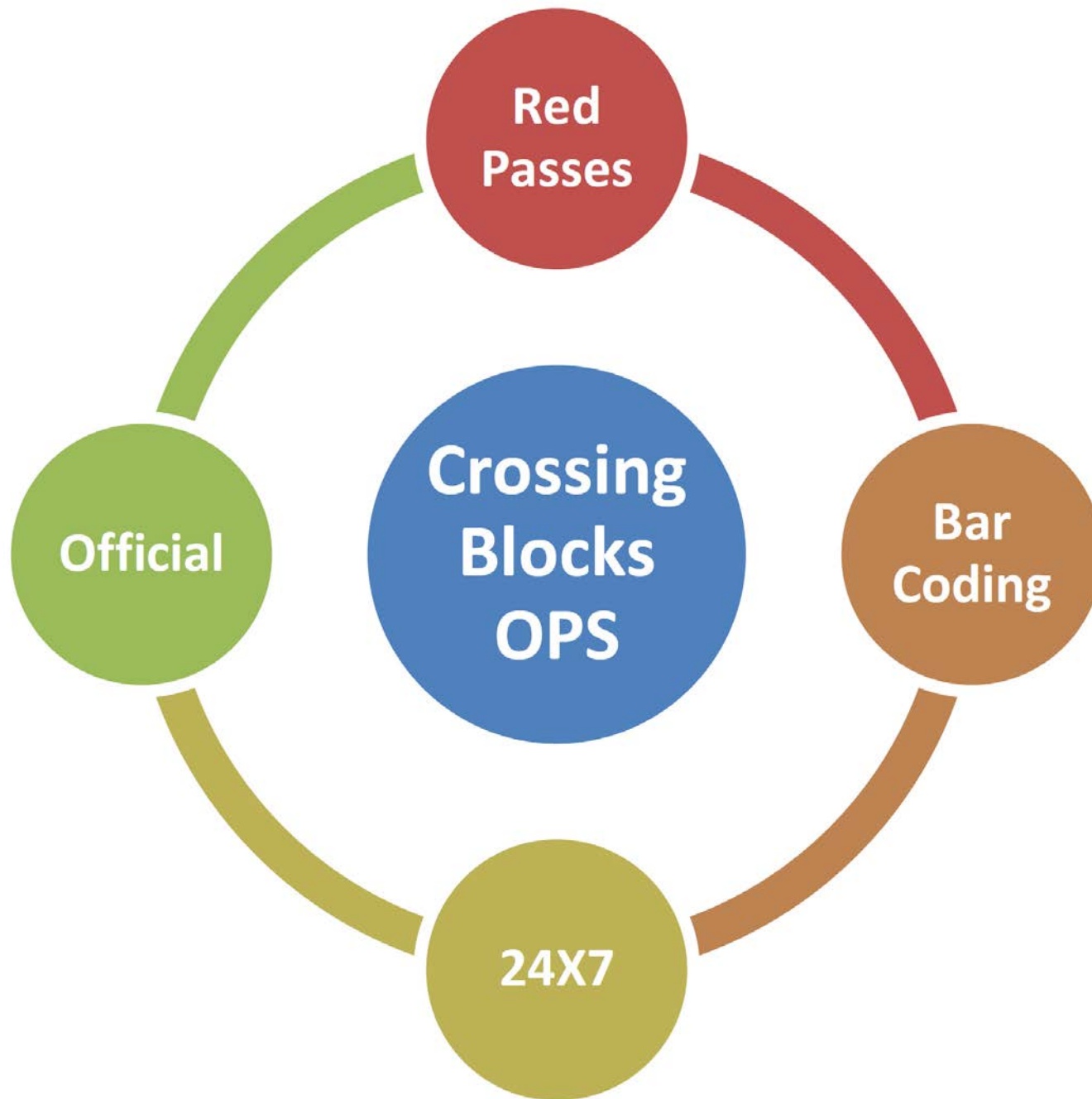


Figure 6. Innovative processes for Southern PZ Operations.

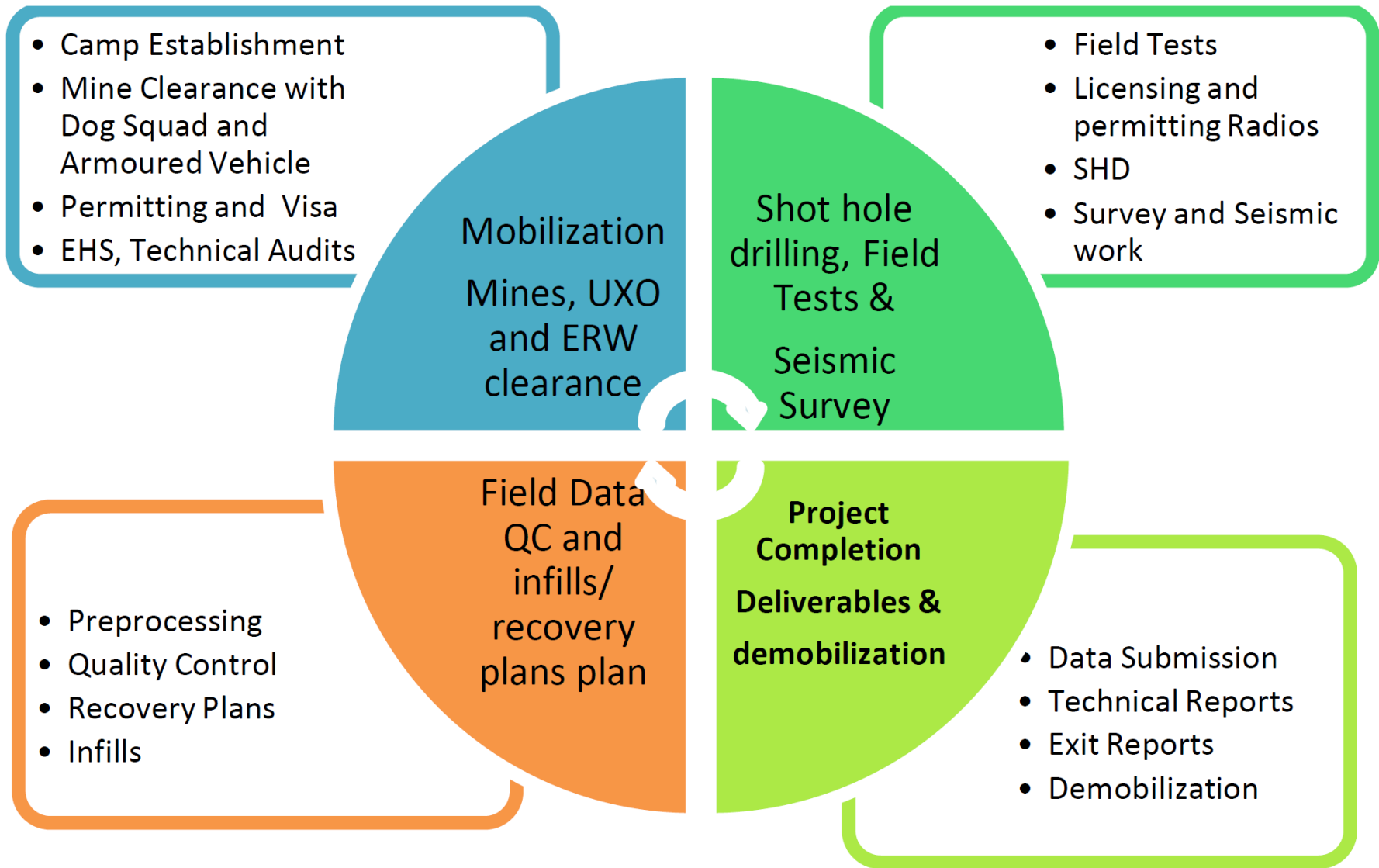


Figure 7. Macro Map of Operational Activities.



Figure 8. Potential mine field areas of PZ (North).



Figure 9. Main Challenges in the operational areas.



Figure 10. Armored Vehicle deployed for mine clearance.



Figure 11. Dog Squad operating in the area for mine clearance.



Figure 12. Communicating with the lifesaver dog.



Figure 13. Special machinery deployed in field.



Figure 14. Specialized vehicles stuck in deceptive Sabkhas.



Figure 15. Demonstration and signage in operational area.



Figure 16. Field demo and training sessions.

Block	Source Area km ²	Receiver Area km ²
1	1793.6	1793.6
2	1852.3	1852.3
3	1700.2	1700.2

Table 1. Acquisition Blocks dimensions.