Enhancing Accuracy in Staking and Mapping of New Locations Using in-house Developed Softwares to Minimize the Development / Exploration Risk

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Summary

Staking of new well locations is an important part of developing oil and gas fields. Locations are proposed on hard copy of geological maps where the facility of creating / editing of a soft copy of the map is not available. To achieve high accuracy in transferring the location from the map to the ground and viceversa, various software packages have been developed in-house and are integrated with Differential Global Positioning System (DGPS). The adopted new methodology minimizes the development / exploration risks that might be caused due to positioning errors. How ever this methodoloty is highly userful where work-stataion or similar facilities are not avaible.

Introduction

In a field under development, the wells are proposed at a technically suitable location on a structure contour map of the pay. If the proposed locations are plotted on the soft copy of the map then their co-ordinates are readily available. However where there is no such facility available the proposed location are released with reference to the existing wells and the same are used for staking of the location on the ground. The manual methods of measurements on map and ground are liable to the introduction of errors.

Sources of errors

Measurements done on a map of scale 1:20000:

- The least count of measuring scale is 1 mm which is equivalent to 20 meters on the ground.
- The thickness of the line/dot is of 0.5 mm which is equivalent to 10 meters on the ground.
- The least count of protractor is of 30 seconds.
- Subjective human errors intervene at every stage of measurement.
- Manual measurements of bearing and distances on ground: Local magnetic field affects compass readings in the field.
- Traditional methods adopted to measure the long distances greater than few chain lengths.

These errors may result in crossing error of reference distance and directions from the reference points. If these crossing erros are ignored and not recorded on the maps, any release of new location with reference to this well adds to cumulative error. It is observed that in some of the matured fields the crossing error is more than 100 m.

Sensitivity of accuracy of location to the risk

Most of the locations of well are sensitive to its position with respect to the geological and reservoir features**.** For example: in case of wells proposed near the faults, high precision is required in their staking to ensure the drilling of the well on the proper side of the fault.

Process of staking of location & mapping

Conventional method of staking of locations involves manual survey and locating the point of intersection of two lines from the reference wells. Crossing errors which are normal in this process may be compromised in the field with no records. As mentioned earlier, this usually introduces and accumulates errors at every stage of the process. Usage of DGPS alone can reduce the error to limited extent. Considering these points, a new efficient system is developed to achieve accurate transfer of location from map to ground and from ground to the map.

Software Packages developed

A few software packages have been developed in house to fix the above discussed constraints. (Refer table-1.) DGPS with these software packages minimizes the

Table 1. Functions of various software packages developed in-house.

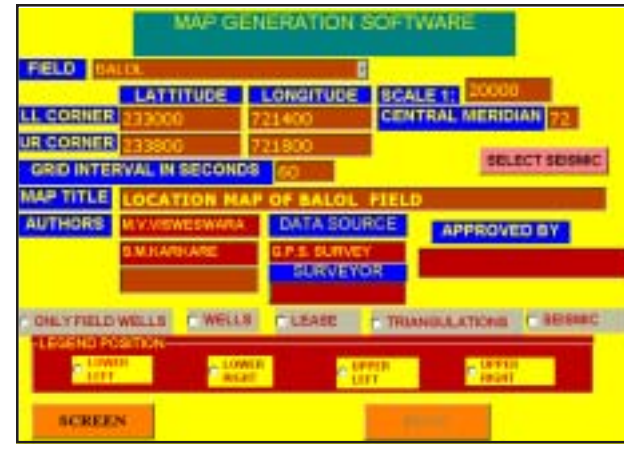
Name	Function
Gpslink	To transfer Ascii data of coordinates form GPS report to database
Mapgen	Complete mapping software with different projections
Crosserror	To compute and to minimize the crossing error
Leasecheck	To find out lease name, type and the nearest well's distance and bearing from the point under consideration
Cogeo	Geometrical calculations like distance, bearing and co-ordinates

human intervention in placing the position of the location on the ground and on the map and enhanses the accuracy.

Crosserror **(**Form 1) software package calculates accurate co-ordinates of a proposed location on the structure/ pay map. The input to the software is names of reference wells, their distance and bearing from the well under proposal. The software takes co-ordinates of reference wells from the database and computes a crossing error. If the crossing error is observed, then in consultation with the proposing authority modifications in bearing / distance of one or both the references is done to arrive at a zero cross error point. This aides to describe locations with coordinates and also with references to existing wells with zero crossing error.

Mapgen ***(***Form 2) software package is used to plot the location map of any selected area in a given scale. This output is used to layover the existing geological maps and relocate the location, if required. Reference points are measured and refined for zero crossing error as mentioned above.

Form 1: *CROSSERROR form



Form 2 *MAPGEN form

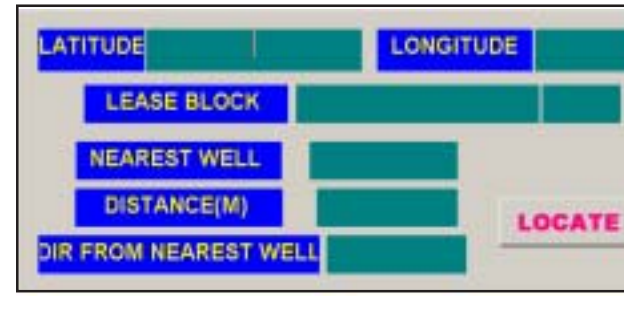
Leasecheck (Form.3) software package is used to find out the lease block name and type of lease for the location. This software works on the principle of finding out whether a point is inside a polygon or not using "Ray tracing technique". Accurate Lease Block information is required in new NELP environment and new statutory requirements.

Methodology adopted to stake a location

The main concern is to achieve high precision in transferring a point from map to the ground and from ground to the map. Due to logistic problems, surface positions of the locations are needed to be shifted. Therefore it is required to provide accurate maps with possible shifted positions for quick decisions. This is very useful in case of horizontal wells where surface shifting has many constraints.

Objectives

- Minimization of errors through computer application software packages to maintain high level of accuracy.
- If any manual measurement is required to be done then it is be further refined and cross checked for accuracy by the computer.



Form 3: *LEASECHECK form

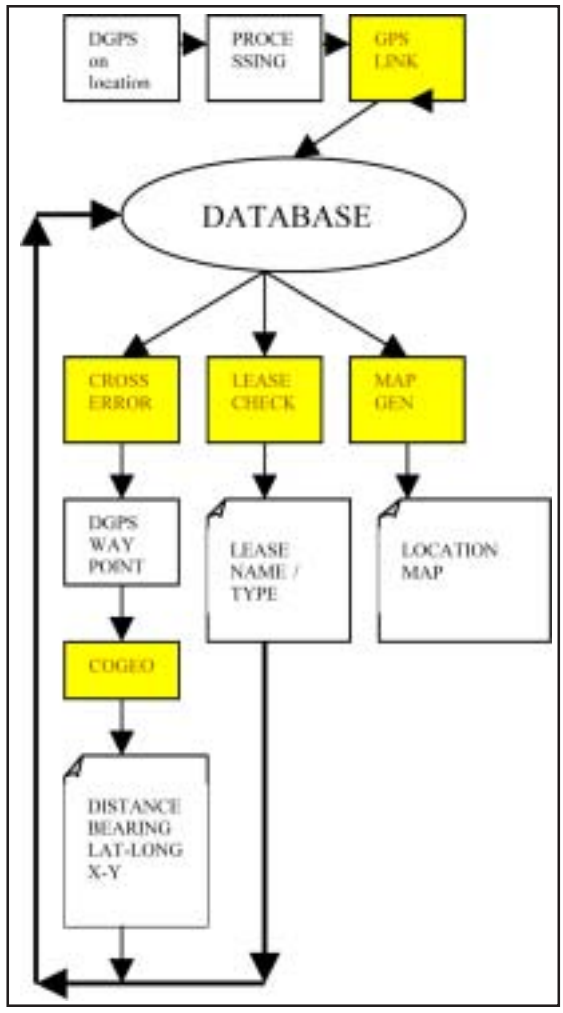


Fig.1: The flow chart

- The manual measurements in the field are to be minimized by making extensive use of DGPS with at least centimeter accuracy.

Methods

1. Record the geographic coordinates of the reference wells from the field using DGPS.
2. Use these coordinates and distance and bearing parameters as input to the software Crosserror calculate the crossing error, if any.
3. Report the crossing error and in consultation with technical team modify the reference parameters for zero crossing error.
4. Using *Crosserror (Form 1) software, calculate the coordinates of the proposed location.

After the coordinates of location with zero-cross error are finalized a surveyor stakes the location on the ground. For this purpose a facility called "way point" in GPS is used. As the centimeter accuracy co-ordinates of the location are available, GPS guides the surveyor to reach the location within a radius of few meters. This point is marked and using DGPS, centimeter accuracy co-ordinates are found out. Back in office the distance and bearing of a released location from the staked point are found out by using ***Cogeo** (form 4) software package and staked point is shifted by the calculated distance and bearing. Normally the shift distance is within 3 meters so there is less chance of error in manual shifting. If there is any surface or subsurface shift, ***Cogeo** and ***Mapgen** are used to prepare drilling profile and to ensure that the drilling profile does not encounter any of the existing wells.

Advantages of the new techniques

1. Locations are staked to the accuracy of centimeter.
2. In case of the deviated / horizontal well, path of the well can be accurately planned to avoid any encounter with the existing wells.
3. Removes doubts in the mind of users about the position of well vis-à-vis the map.
4. All the wells are referred with geodetic coordinates.
5. Users can make most optimal informed techno-economic decision, in case surface shifting is required.
6. NELP regulations and statutory requirements can be strictly adhered to.
7. All the data are recorded into database with complete details.

At Mehsana Asset the recording of coordinates of of all the existing wells using DGPS has been completed

Form 4: *COGEO form

and a data base of centimeter accuracy coordinates for all the wells are available. All the locations are staked adopting above mentioned methodology. With this, conventional survey has been discontinued and has been resulted in to more accurate base maps.

Conclusions

Location staking and mapping are key elements in translating oil exploration and development programmes into reality. Mitigation of risks related to ongoing practices due to errors in positioning have been countered successfully with new techniques which is combinations of computer software packages developed in-house and DGPS. It is now possible to obtain on ground "zero crossing error' location as experienced in Mehsana Asset.

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