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Data Acquisition, Transfer and Processing for Multi Channel Permanent PMM Systems

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SUMMARY

This paper discusses the acquisition, transfer and subsequent processing/presentation of data from four different permanent PMM installations. The installations differ in both size, location, data processing procedures and ultimate function.
In terms of complexity, capability and addressability this new Aramco PMM system probably represents the current state of the art in permanents deployed, unmanned passive microseismic monitoring systems. The paper concludes with a review of system data handling capabilities as they currently, or will soon, exist using the characteristics of this new system for illustration purposes.

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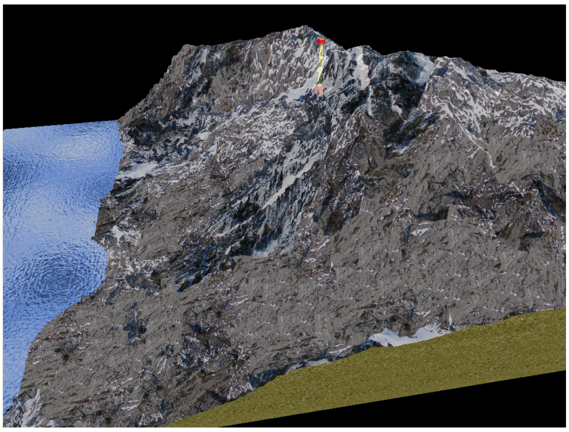
Example # 1. Small remote system installed for reasons of public safety - The system described here is located a high altitude on a remote and inaccessible mountain in Western Canada. About a century ago a major slope failure obliterated a community in the valley below. Ongoing concerns about the stability of the slide and the condition of the deep seated failure surfaces resulted in the installation of a comprehensive stability monitoring systems. One component of the system is a PMM system which monitors the output of an array of borehole and surface geophones. The raw data is continuously transmitted over an RF link to a base station where the location and magnitude of events are calculated. The base station also houses equipment for providing a warning to the community.

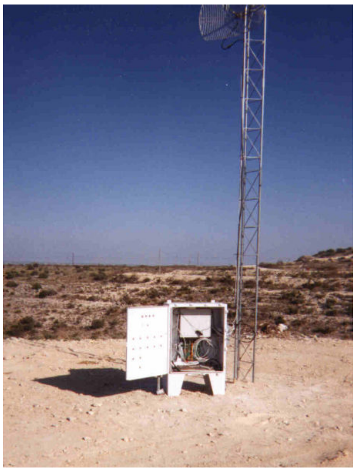
Event location data is displayed in real time on a three dimensional model of the site. The model has been derived from a combination of satellite and air photo imaging and geological data.

Figures show an installation on a remote mountain and below a 3D model which depicts the mountain face and plots the sensor locations as well as event hypocentres.



Example # 2. Medium sized distributed system monitoring the effects of CO_2 injection into a hydrocarbon reservoir in West Texas - The PMM system monitoring this highly productive field consists of four remote nodes and one base station. The remote stations are located at the collars of observation wells which are all about 1500m deep. The wells contain multi element 3C geophone packages operating at temperatures in excess of 200C and pressures of approximately 50MPa. The system nodes communicate with the base station using a bidirectional UHF link which also carry redundant GPS timing signals.

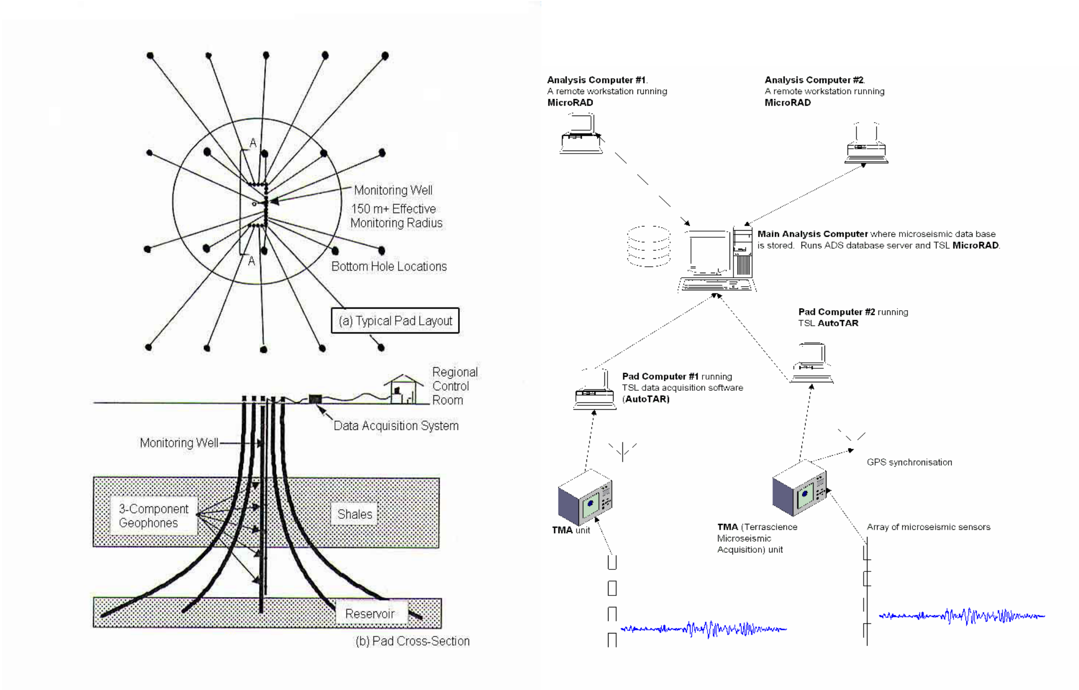
At this site the irregular topography and the non-intervisibility between the remote locations necessitated that considerable redundancy be incorporated in the communications system. From the base station an ADSL connection transfers a combination of processed and raw data to a remote location. Communications protocols associated with the transfer and processing of the microseismic event data are described in the context of the actual field conditions.



Figures show a PMM system monitoring a CO_2 injection into a hydrocarbon reservoir in West Texas.

Example #3. Large distributed systems in Northern Canada monitoring multiple production pads using cyclic steam stimulation to produce heavy oil - These installations monitor approximately 110 production pads using 3C geophones installed as linear arrays in vertical observation wells. Nearly two thousand channels of data are being acquired simultaneously by these fully automated systems.

Software optimised for the analysis of data acquired from linear arrays of 3C geophone packages is used to derive event location, source parameters, and magnitude. Examples of the interpretation and solution of microseismic event records are given.



Figures show large distributed systems in Northern Canada monitoring multiple production pads using cyclic steam stimulation to produce heavy oil.

Example # 4. Distributed system in Saudi Arabia incorporating both near surface and borehole 3C geophone packages - This integrated system consists of approximately eight hundred sensors and more than 230 acquisition nodes. The nodes range in size from 3 channel units acquiring data from near surface geophones to 72 channel units monitoring 3C sensors installed to depths of 2000m. The system is unique in that it covers a significant area, ≃9 kms^2, and utilizes a combination of high sensitivity sensor packages, distributed acquisition/communication units incorporating 24 bit A/D converters and integrated high speed/optical fibre modems. Large volumes of digital data are simultaneously acquired and distributed over approximately 54 kms of optical fibre cables. On site data management is handled by unmanned processing units designed to operate continuously at ambient temperatures in excess of 60^{0}C. The raw data is then transferred by fibre and a broadband RF link to an automated processing unit which undertakes multiple functions including event detection and archiving. The event records are transferred in real time to designated recipients in Kingdom of Saudi Arabia, Canada, the USA and France.

In terms of complexity, capability and addressability this new system probably represents the current state of the art in permanents deployed, unmanned passive microseismic monitoring systems. The paper concludes with a review of system data handling capabilities as they currently, or will soon, exist using the characteristics of this new system for illustration purposes.

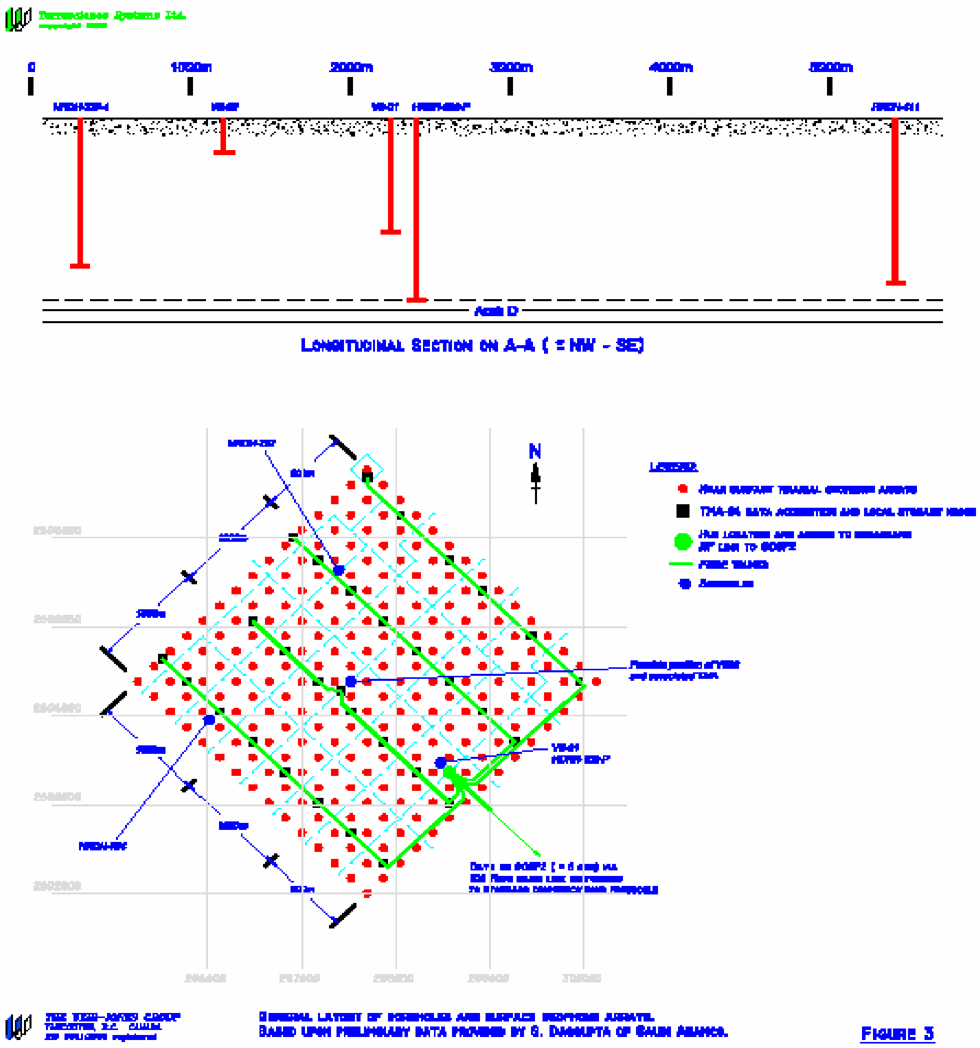


Figure Shows PMM system consisting of both near surface and downhole geophone arrays.