DOE/EW/12823--74

REMEDIATION PLANNING AND RISK ASSESSMENT SUPPORT THROUGH DATA FUSION TECHNOLOGY

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APR 04 1996

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Coleman Research's data fusion modeling (DFM) services give you the ability to use large geophysical and hydrological data sets, which include direct and indirect measurements, to obtain a unified mathematical model of the geology and hydrology at your site. Coleman Research (CRC) has adapted highly stable and efficient statistical inversion techniques, developed over the past 20 years, to provide a 3D site model with quantified uncertainty based on state-of-the-art modeling codes. This site model supports risk assessment and remediation planning with enhanced numerical accuracy for tradeoff studies of alternate remediation strategies. Further, DFM supports real time model updates during remediation and site investigation.

DFM services are offered in a virtual office that puts our fusion professionals electronically on-site with you using our Data Fusion Modeling/Virtual Office (DFM/VO) software product. With an inexpensive workstation or PC, your site will have immediate access to the most up to date versions of the data fusion, data management and 3D visualization software and to CRC's data fusion engineering staff.

Using the DFM/VO, you will have networked sharing of the software licenses for preparation of the fusion input data, guidance in use of the data fusion computational engines, and visualization of the fusion results. On each project, you will determine the amount of consulting time that is required from the CRC data fusion staff. We can do the whole job from data capture to final visualization or we can provide training and on-line/on-call assistance to your staff.

DFM input includes a site conceptual model and the following data: well log, seismic reflection and refraction, time and frequency domain electromagnetic, DC resistivity, cone penetrometer and geoprobe, hydraulic head and conductivity, recharge and contaminant concentration. DFM outputs include 3D delineation of geology, hydrological parameters, flow pathlines, and contaminant distribution. DFM results can be provided as 3D EarthVision faces files; images in RGB, GIF, postscript or TIFF format; color or black and white viewgraphs; or as a video tape walk-through of the site subsurface.

The Virtual Office features include software license sharing, video conferencing, electronic mail, text and image file transfer, electronic blackboard and interactive/batch access to workstation resources for solving your hydrogeologic modeling problems. For further information contact Dave Porter in the Columbia Maryland Coleman Research office at (301) 621-8600 or email dave_porter@mail.crc.com

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DATA FUSION MODELING VIRTUAL OFFICE

For further information contact dave_porter@mail.crc.com

GridBuilder – Automates Hydrologic Grid Construction

Starting with site surface map, provides rapid construction and cross sectional viewing of complicated three dimensional hydrologic grids.

A component of the data fusion graphical interface that allows complete specification of the 3D hydrological grid, the boundary conditions and initial parameter values at each grid node.

Conformal Grid with user specified hydrologic layers nested within geologic units established from previous data fusion of direct and indirect lithologic data from one or more sources

File Utilities Help

GridBuilder

Define Regions

-2268.16 -1544.74

Type in a region name, then outline the region with mouse btn 1.

2 Regions

Region Name:

2

Region Up Down

Properties

Add Region

New Region

Load Map

Add Sublayers

Region Extents

Boundary Cond

DOE HANFORD 200 WEST AREA SITE INVESTIGATION

Data Fusion Modeling (DFM) was used at the Hanford 200 West Area to determine the distribution of contaminants relative to geological features. The objective was to map a thin caliche layer 30 to 40 meters below the surface in the vicinity of the tile fields where contaminants were discharged. Scattered well data with caliche picks were provided by the Hanford site personnel. In order to obtain a more detailed characterization, CRC conducted a geophysical survey to obtain densely spaced non-intrusive data. The survey consisted of four seismic reflection and refraction lines which are shown in the next page. The availability of DFM allowed CRC to use a new "roll along" method to collect very high density seismic refraction data along lines 1 and 2. The "current practice" GRM seismic layout was used to collect lower density seismic refraction data along lines 3 and 4. Due to the site specific safety practices, it was not possible to obtain any seismic checkshot data on velocity.

The next page shows the DFM results using seismic measurements and well picks for the Hanford 200 West Area. The top of the caliche layer, a possible barrier to contaminant movement, is shown at the bottom of the chair cut.

Top of caliche picks were obtained from 25 wells. The individual interpretations for seismic reflection and seismic refraction data, without checkshot information, provide almost no information on the caliche topology. Using reflection data alone, inadequate seismic velocity information was available to interpret travel times as depths to the caliche. The caliche did not support a refraction so no depth information was available from the refraction measurements.

DFM, by jointly processing all of the data, uses seismic velocity information from the refraction measurements to interpret the reflection travel times as depths and uses the well data to calibrate and validate the model. This demonstrates the value added by the ability of DFM to produce a complete picture from several data types. Further, DFM quantifies the geologic uncertainties as shown by the 1-sigma (one standard deviation) confidence bounds on the top of the caliche displayed on the next page.

The last page shows the Plutonium relative to the geology below a tile field. Note that the plume is above the estimated caliche depth with a few isolated points on the caliche within the confidence bound uncertainty. Further, the bulk of the plume is above a geological layer located above the caliche that is shown with the 1-sigma confidence bounds provided by DFM.

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Hanford 200 West Area: Geologic Fusion Results

Display: delx, p2, faces
 Z exaggeration: 4.0
 Azimuth: 21.8
 Inclination: 26.0
 X Chair Cut: 120.0
 Y Chair Cut: 480.0

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Hanford 200 West Area Plutonium Plume Under Tile Field Superimposed on Geologic Model

DOE PANTEX REAL-TIME PATHLINE CHARACTERIZATION

Data Fusion Modeling (DFM) was used at the DOE Pantex Site to determine the flow pathlines in a perched aquifer above the Fine-Grained Zone (FGZ) aquitard. The main objective was to determine potential contaminant pathways to the Ogallala aquifer located beneath the FGZ. Geological data fusion was used to map the top of the FGZ using lithologic and geophysical logs provided by the Pantex site personnel. Hydrological data fusion was used to determine the flow in the contaminated perched aquifer above the FGZ using perched water level measurements, slug tests, and recharge information. Flow data fusion was done in real-time to aid in the guidance of site investigation to optimize the location of new borings – a capability never before available with manual model calibration. The CRC model was the first unified hydrogeological model that defines pathlines based on all available data at this site.

The next page shows geological DFM results derived from about 50 lithological and geophysical well picks to map the top of the FGZ in the Pantex area. The top of a channel that 'bends' the flow toward the East can be seen on the next page.

A groundwater flow model was calibrated using about 37 perched water level measurements and several hydraulic conductivity (slug) tests. Using hydraulic conductivity data alone, very little information was obtained about the flow and subsequent pathlines in the Pantex area.

But DFM, by jointly processing all of the data, and constraining the solution using physical flow models, is able to map the complicated heterogeneities that typically drive contaminant flow and transport. In fact, the amount hydraulic conductivity (heterogeneity) data is essentially *extended* because head measurements can serve as surrogates through the physical hydrological models. Further, DFM quantifies the hydrological uncertainties because a sufficient amount (statistically) of data on hydraulic conductivity is effectively available. This demonstrates the value added by the ability of DFM to produce a detailed map of the heterogeneities from several data types with quantified uncertainty. Further, the process can be completed in real-time because of the speed of DFM's patented algorithms.

The last page shows the flow pathlines in the perched aquifer. One of the primary sources of recharge that caused the mounding near Playa 1, was discharge from the Zone 12 facility. An arrow indicating the direction of the primary surface recharge is displayed with a dashed line. Monitoring well locations are displayed as dots.

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FINE-GRAINED ZONE ELEVATION

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HYDRAULIC HEAD AND PATHLINES

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Savannah River Site (SRS) Old Burial Ground Hydrologic And Transport Modeling

The following figures show the 3 dimensional contaminant pathways superimposed on the site lithology and the tritium concentration at Fournile Branch from 1960 to 2030. The hydrologic forward model used in the data fusion was VAM3DF, which models saturated-unsaturated groundwater flow and solute transport with variable water table position and highly non-linear soil moisture conditions.

The concentration curves were generated via 1000 monte carlo replications using the parameter covariance matrix from the hydrologic fusion to provide the required statistical distribution parameters. Notice that the actual measured tritium concentrations vs time are within the 90 percent confidence bounds of the model predictions.

Alternative conceptual models can be rapidly evaluated with DFM in order to obtain the best final model. This frees the hydrologist from much of the current trial and error manual calculations and provides better control over the modeling process.

CRC has installed the data fusion software on Silicon Graphics workstations at SRS and provided complete documentation and on site training to WSRRC personnel. WSRRC will use this system for remediation planning and monitoring at other sites within SRS.

CRC's data fusion modeling (DFM) was used with the HydroGeologic, Inc. flow and transport model VAM3DF at the SRS Old Burial Ground (OBG) to develop a groundwater flow and transport model. The OBG is the original solid radioactive and hazardous waste burial ground for the SRS General Separations Area (GSA) where solid waste was deposited from 1952 to 1972. This study addressed the transport of tritium which has migrated south of the OBG toward Fournile Branch. The resulting DFM model was compared with an existing flow and transport model calibrated via the current practice trial and error method. The two models had similar pathways, recharge and trends in conductivity. The DFM model provided a better fit to the head data and better stream flow prediction in addition to quantification of the uncertainty in the tritium breakthrough curves.

The development of the DFM flow and transport model of the OBG relied heavily on the work of Westinghouse Savannah River Company (WSRC), the developers of the existing model for the site. WSRRC used detailed lithologic data, including mud fraction measurements to construct a heterogeneous conductivity field.

DOE Savannah River Site

Old Burial Ground, Trinity Parish, Louisiana

Water Table
Aquifer

Old Burial
Ground

Source

Monitoring Points

Barnwell/McBean
Aquifer

Pan Clay Region

Congaree

Ellenton Clays

Tritium Discharge Concentrations to 4-Mile Branch

– Includes Recharge, Conductivity, and Source Uncertainties –

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