

# **PRELIMINARY ANALYSIS OF SPOIL SETTLEMENT AT A MOUNTAIN-TOP-REMOVAL COAL MINE: STAR FIRE TRACT, EASTERN KENTUCKY COAL FIELD<sup>1</sup>**

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## **SETTING**

The method of mining coal by the mountain top removal (MTR) process can create gently rolling land that may be used for multiple purposes that provide economic diversity for the Eastern Kentucky Coal Field region, part of the Appalachian Plateau physiographic province. A major limiting factor of post-mine development is the settlement of mine spoils over time. Between 1981 and 1996, approximately 1,000 acres of land were mined at the Star Fire Mine in Perry, Breathitt, and Knott counties by MTR processes using shovel and truck, and a 64-yd<sup>3</sup> bucket dragline (Fig. 1). Spoil thickness ranges from approximately 50 ft to 300 ft over buried valley fills with a large percentage of the area having approximately 200 ft of spoil. Two publications detail the mining process and spoil hydrogeology, and initial spoil settlement around groundwater monitoring wells (Wunsch et al., 1992, 1996). From September 1995 to August 2000, seven leveling surveys were completed on 80 monuments placed on 200 ft centers (where possible) along four lines (A through D) across the spoil (Fig. 1). The vertical precision of these surveys is 0.01 ft.

## **LIMITATIONS**

Many different and difficult-to-define factors play potential roles in the amount and duration of settlement. This presentation focuses primarily on the age of the spoil. First, upper coal seams were mined by conventional shovel and truck methods, and then the lower two seams were mined by the dragline, which placed most of the spoil. Annual aerial photographs were used to

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define the progression of the dragline mining from 1981 through 1996. Because these photographs were only taken once a year or less frequently, generally in the spring, the actual boundaries of mining for each calendar year were estimated. Other factors that cannot be readily assessed at this site include the sporadic end dumping of spoil by truck on top of spoil place by the dragline, subtle changes in the thickness of spoil, and re-grading of the spoil through time. Significant settlement occurred without regard to spoil age in most monuments in lines B, C, and D between the initial elevation measurement (1995) and the next measurement one year later. This occurrence is not yet explained. One factor that was constant throughout the site was that of the lithologies of the overburden.

### **SPECIFIC SETTLEMENT OBSERVATIONS**

All ages of spoil are estimated from the year that the dragline operated in an area prior to the year 1995 when the survey monuments were installed, and the first elevations were measured. Because of the limitations listed above, it was difficult to generalize settlement characteristics among all 4 monument lines (A through D). Therefore, the following discussion focuses on monument behavior along each line.

Line A was only 600 ft in length, and consisted of four monuments across spoil placed in a valley during contour mining prior to commencement of MTR process in 1981 (older than 14 years) (Fig.1). Spoil in this area was estimated to be approximately 50 ft thick, and settlement during the five years of measurement ranged from 0.01 to 0.06 ft.

Lines B through D were oriented somewhat perpendicular to the dragline cuts; therefore, monuments along each line transcended the time of spoil placement (Fig. 1). Line B was 3,560 ft in length and the spoil ranged in age from 10 to 8 years old (1985 to 1987). Total spoil settlement ranged from 0.43 to 0.70 ft for the 5-year period of measurement. Noticeable rebound (0.10 to 0.19 ft) occurred in the older spoil (1985 and 1986) during 1997-98 (Fig.1). We speculated that spoil placed in 1997 by end-dumping by trucks on top of 1987 spoil along the southern part of the line, may have provided significant stress to lift the older spoil. From 1998 to 2000, this older spoil resettled to below its initial measurement in 1995 by a few hundreds of a foot.

Line C was 4,290 ft in length, and the spoil ranged in age from 14 to 7 years old (1981 to 1988) (Fig.1). The range of settlement was 0.40 to 2.39 ft for the 5-year period of measurement. There was a distinct difference in the amount and rate of settlement between spoil younger than 8

years and spoil greater than 8 years old. Monuments in the 7-year old spoil (1988) had an average settlement of 1.46 ft/monument, whereas the older spoil (1981 to 1987) had an average settlement of 0.55 ft/monument where not impacted by later reclamation. In this older spoil, there was an area that was mined from 1981 through 1982, but the 200 ft pit was reclaimed from 1986 to 1991 (?) by end dumping from trucks. Monuments in this area subsided an average of 1.39 ft during the five years of measurement.

Line D was 5,600 ft in length, and the spoil ranged in age from 14 to 5 years old (1981 to 1990). The range of settlement was 0.29 to 1.90 ft and, again, there was a distinct difference in the amount of settlement between spoils younger than 8 years and older than 8 years. The youngest spoil (as young as 5 years) had an average settlement of 1.70 ft/monument whereas the older spoil (pre 1988) had an average settlement of 0.53 ft/monument.

Four magnetic borehole settlement systems (MBSS) were installed in November, 1997, with six to nine magnetic sensors each, on 22 ft vertical centers (one in 1983 spoil, one in 1991 spoil, and two in 1993 spoil) (Fig. 1). The MBSS were measured monthly in 1998, 9 times in 1999, 6 times in 2000, and in February and May in 2001. They indicate that the majority of the settlement occurred in the upper 80 ft of spoil. As expected, the 1983 spoil settled very little (0.18 ft) whereas the much younger spoil (1991), settled 1.77 ft. Unexpectedly, the two MBSS in the even younger spoil (1993), only settled 0.29 ft and 0.20 ft.

### **SUMMARY**

The above observations indicate that spoil greater than 8 years old had a distinctly lower total-settlement magnitude (approximately 0.50 ft) than younger spoil (approximately 1.50 ft). In addition, the four MBSS indicate that the majority of the settlement occurred in the upper 80 ft of spoil. This zone was most likely placed by the dragline, but was modified by end dumping of spoil by trucks in isolated areas, and by final bulldozer grading. There is evidence in line C monuments that thick, end-dumped spoil from trucks has similar settlement to that of dragline-placed spoil of the same age and thickness.

## REFERENCES

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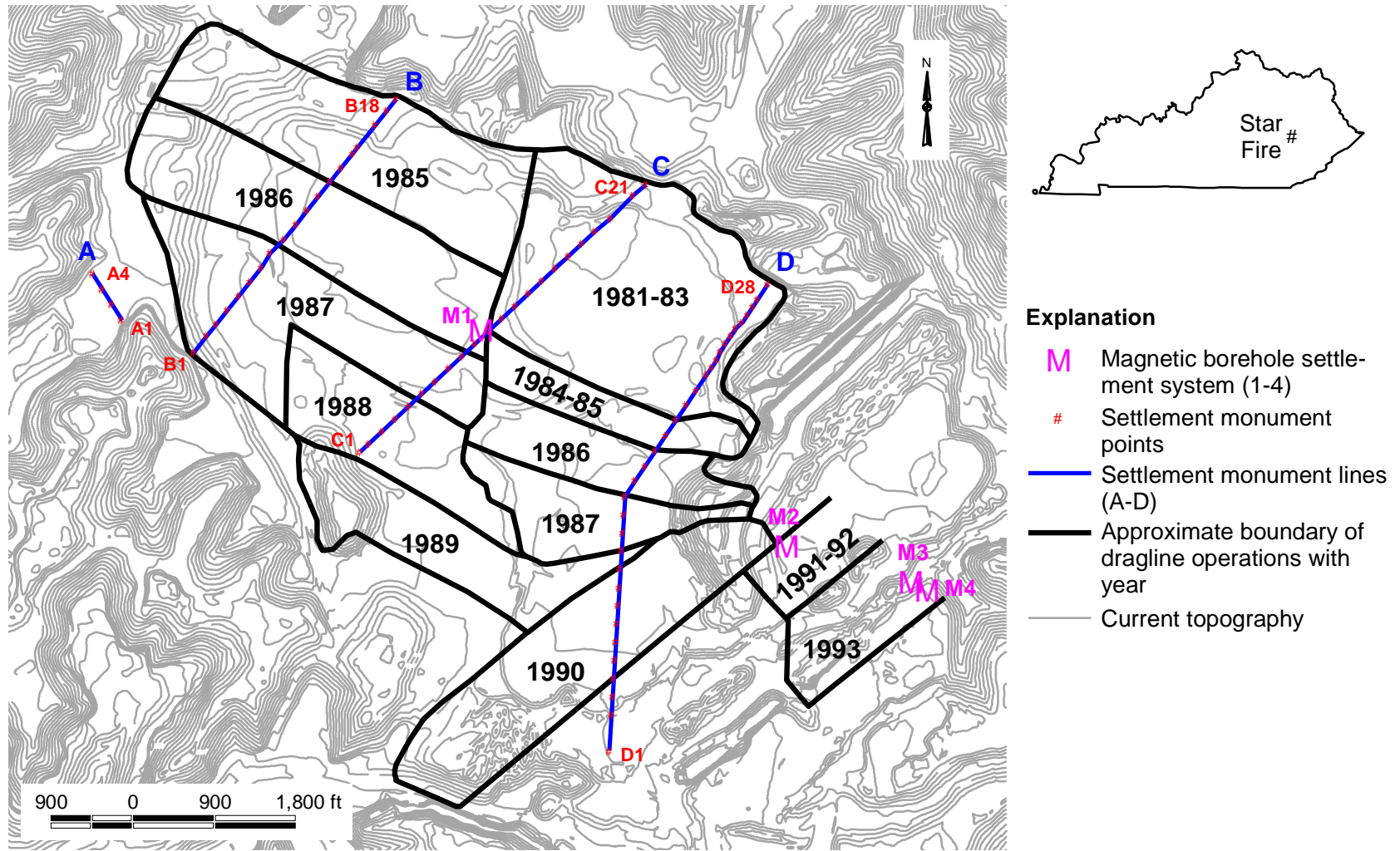


Figure 1 - Location of settlement monuments and approximate boundaries of dragline operations.