

Underground Adventures: A Memorable Internship Experience

Zhiyang Chen

Department of Energy and Mineral Engineering, G3 Center and EMS Energy Institute, The Pennsylvania State University, University Park, PA-16802, USA;
Email: zxc5307@psu.edu

Introduction

During my master's studies, I interned at a coal mining company in China, where I worked on the installation of a spontaneous combustion risk detection system. This hands-on experience deepened my understanding of key concepts and taught me the importance of effective teamwork. Multiple trips underground exposed me to the complexities of mining environments and highlighted the real-world significance of my field in reducing property loss and casualties. This experience has deepened my passion for my profession and reinforced my commitment to making a difference in the industry.

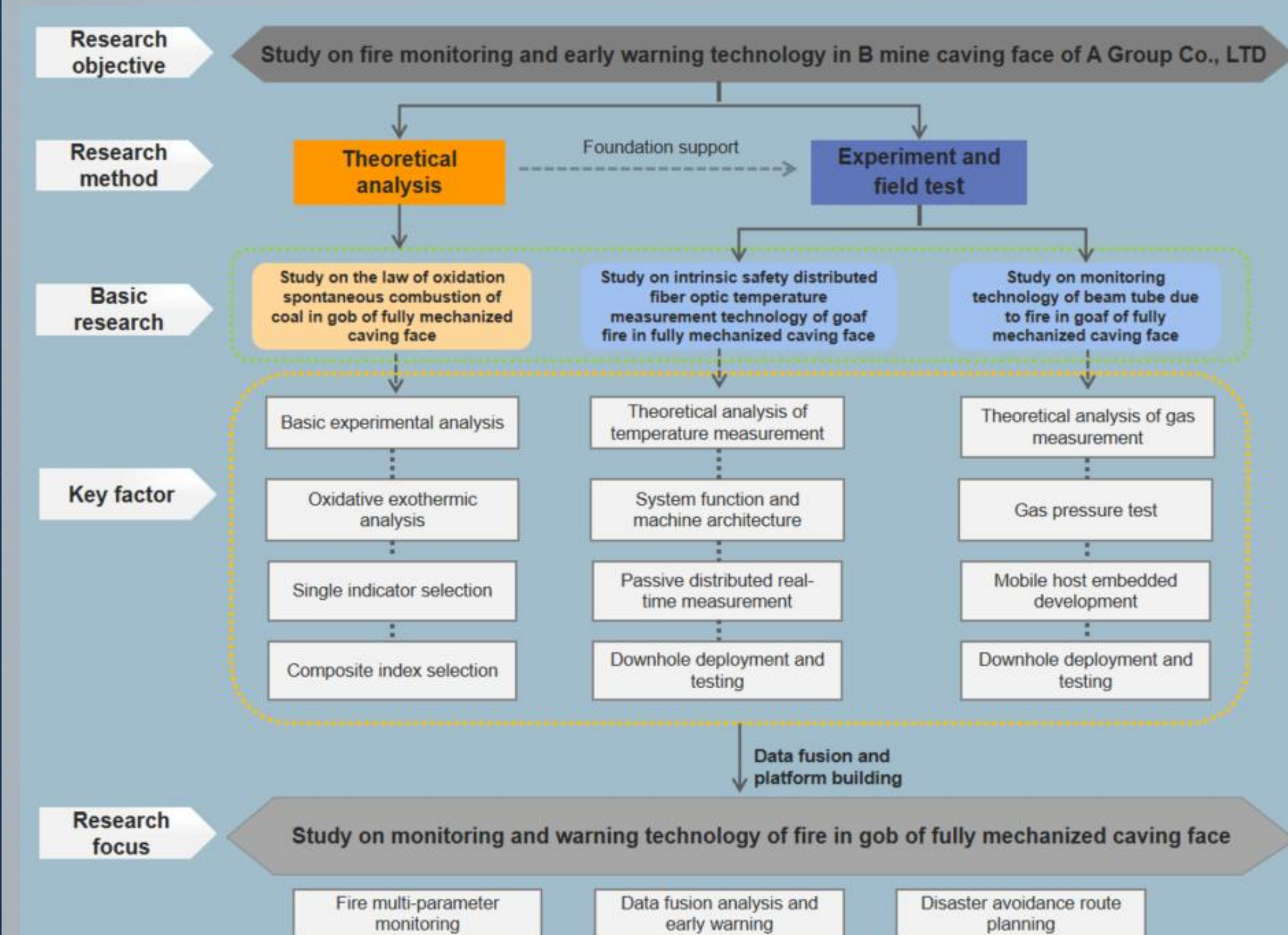


Objectives

The main objectives of my internship project include the following aspects:

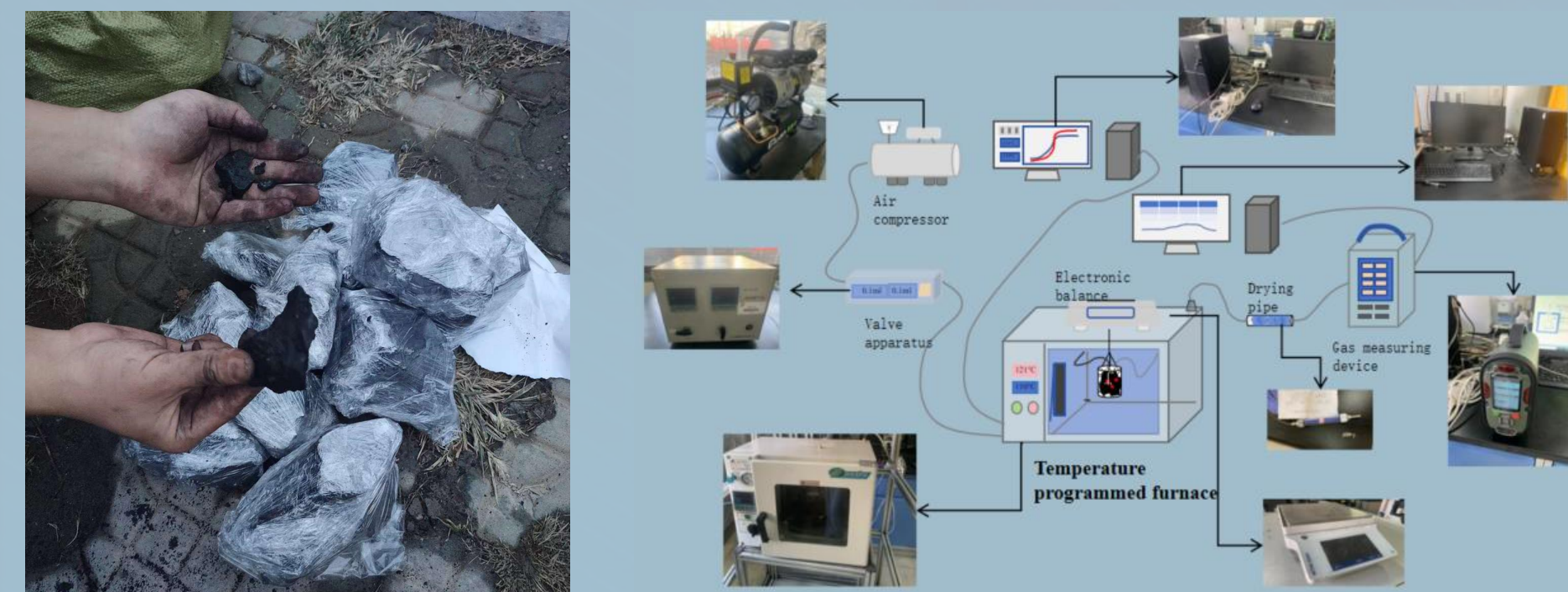
1. Improve monitoring accuracy: Address the low precision and challenges of coal spontaneous combustion monitoring, establishing a fire monitoring and early warning system.
2. Study self-combustion patterns: Analyze the oxidation self-combustion patterns of residual coal in the mining face, establishing a correlation between coal temperature and gas indicators.
3. Develop monitoring system: Design a mobile tube monitoring system and apply positive pressure tube monitoring technology.
4. Integrate advanced technology: Utilize intrinsic safety distributed optical fiber temperature measurement technology for real-time, continuous, and portable temperature monitoring.
5. Establish comprehensive early warning system: Combine these technologies to create a complete fire monitoring and early warning system for mine safety.

Technical route



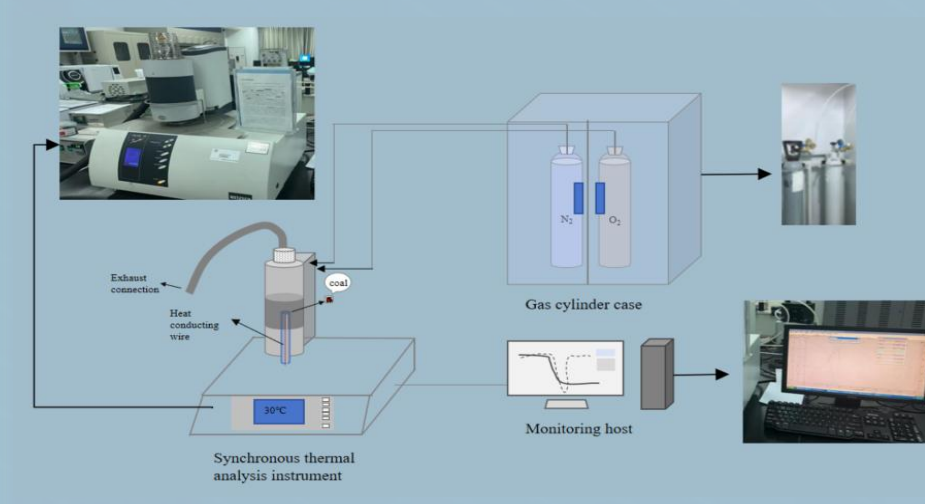
The research approach for this project involves conducting theoretical analysis first, followed by field investigations, thereby combining analysis with practical application. The specific research framework is illustrated in the figure above.

Material and Methods

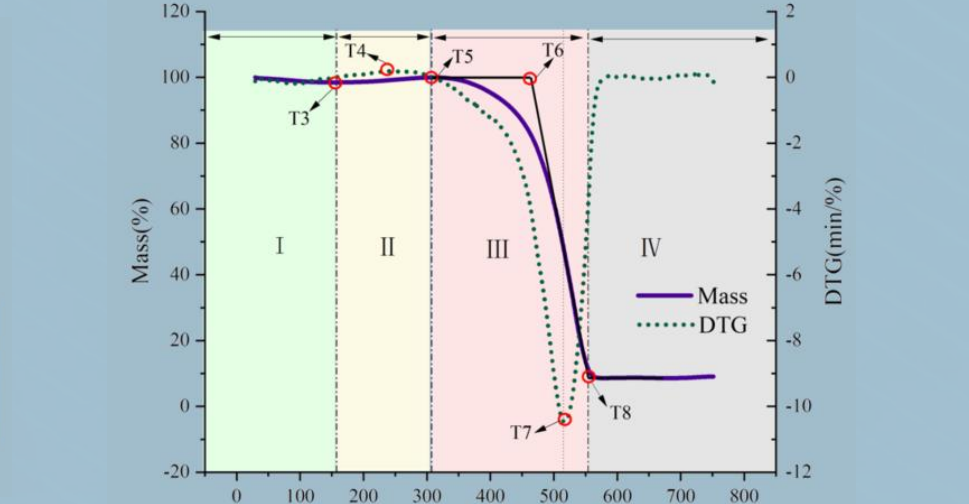


Coal sample

Temperature programmed instrument

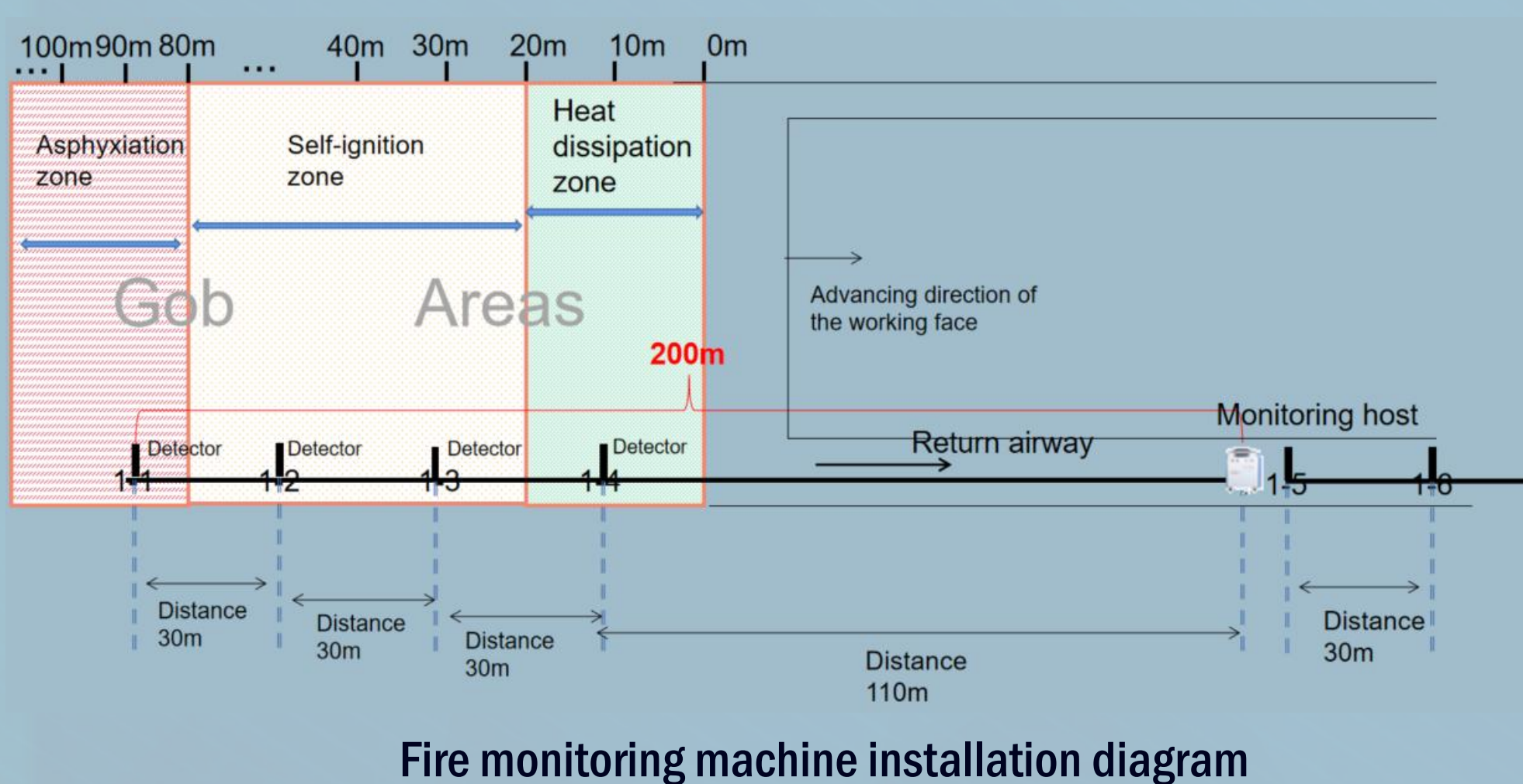


Smultaneous thermal analyzer



Spontaneous combustion stage division

In the first step, we collected residual coal fragments from the mined-out areas underground and sealed them with plastic wrap. Once back in the laboratory, we conducted programmed temperature experiments and synchronous thermal analysis to obtain the gas indicators and characteristic temperature values related to the coal combustion process. These values will help us establish the monitoring indicators for spontaneous combustion in the mined-out areas.



After completing the experimental data measurements, we designed an underground fire detection unit tailored to the actual production conditions of the coal mine. However, the installation process was not as straightforward as anticipated. To help the workers understand how to assemble the unit, I created numerous diagrams and actively participated in the installation work. Many of the workers were older than me, which made the collaboration even more challenging. Ultimately, through our collective effort, we successfully completed the assembly of the device. Having overcome the sweltering surface temperatures and dark underground conditions, I gained a deeper appreciation for the hard work of miners and felt immense pride in my contributions.



Fire monitoring system design draft

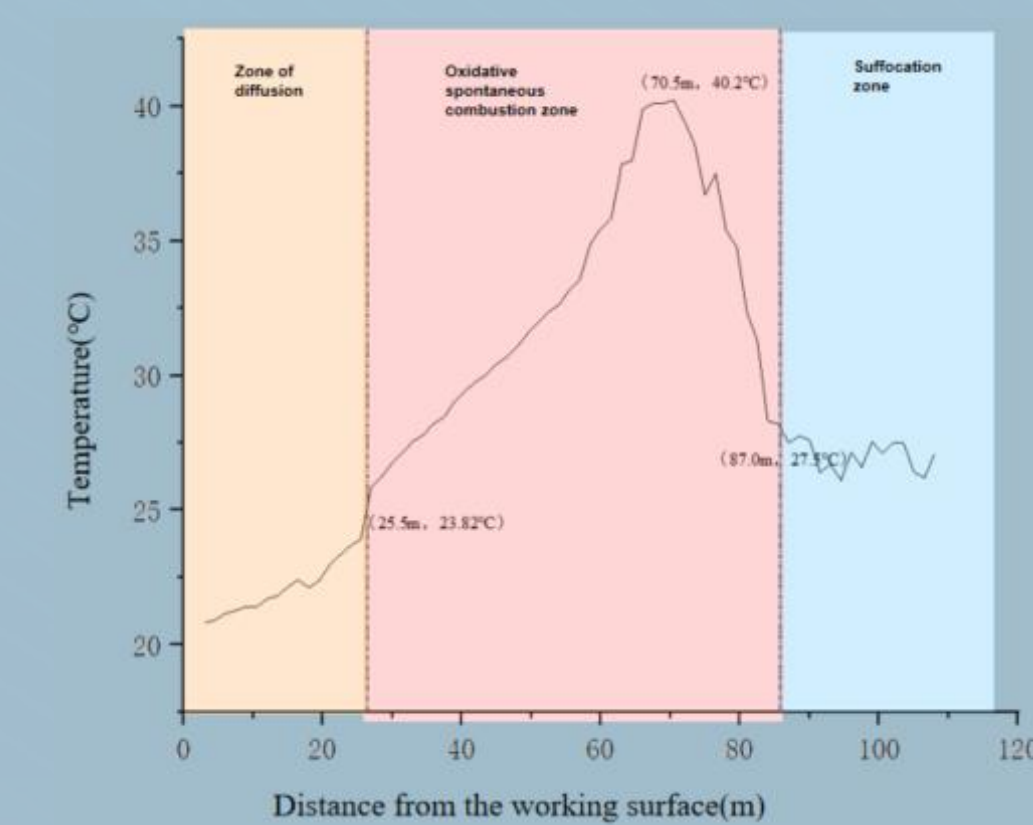
Finally, we developed a monitoring platform, marking my first experience in software development—an unforgettable journey. Based on the coal mine's specific needs, I designed the software's user interface and created the requirements document. After multiple meetings with the IT team, we successfully developed a system interface that met the mine's requirements. This system can intelligently monitor temperature and gas concentration data in mined-out areas, providing smart alerts. It reduces the hassles of manual sampling and effectively minimizes losses for the coal mining enterprise.



Underground fire monitoring platform

Results and Conclusions

1. This project conducted a study on the self-ignition characteristics of the No. 9 coal seam in Mine B, identifying CO and C2H4 as key gas indicators, with a critical temperature of 70 °C.
2. Through field investigations and experimental analysis, an intelligent monitoring system was developed and installed. This system enables real-time monitoring of temperature and gas data in mined-out areas, significantly reducing sampling costs and providing automatic alerts to enhance safety and minimize losses.
3. The application of the monitoring system generated substantial data, revealing the self-ignition "three zones" of the coal seam, with a minimum daily advance rate of 0.74m.



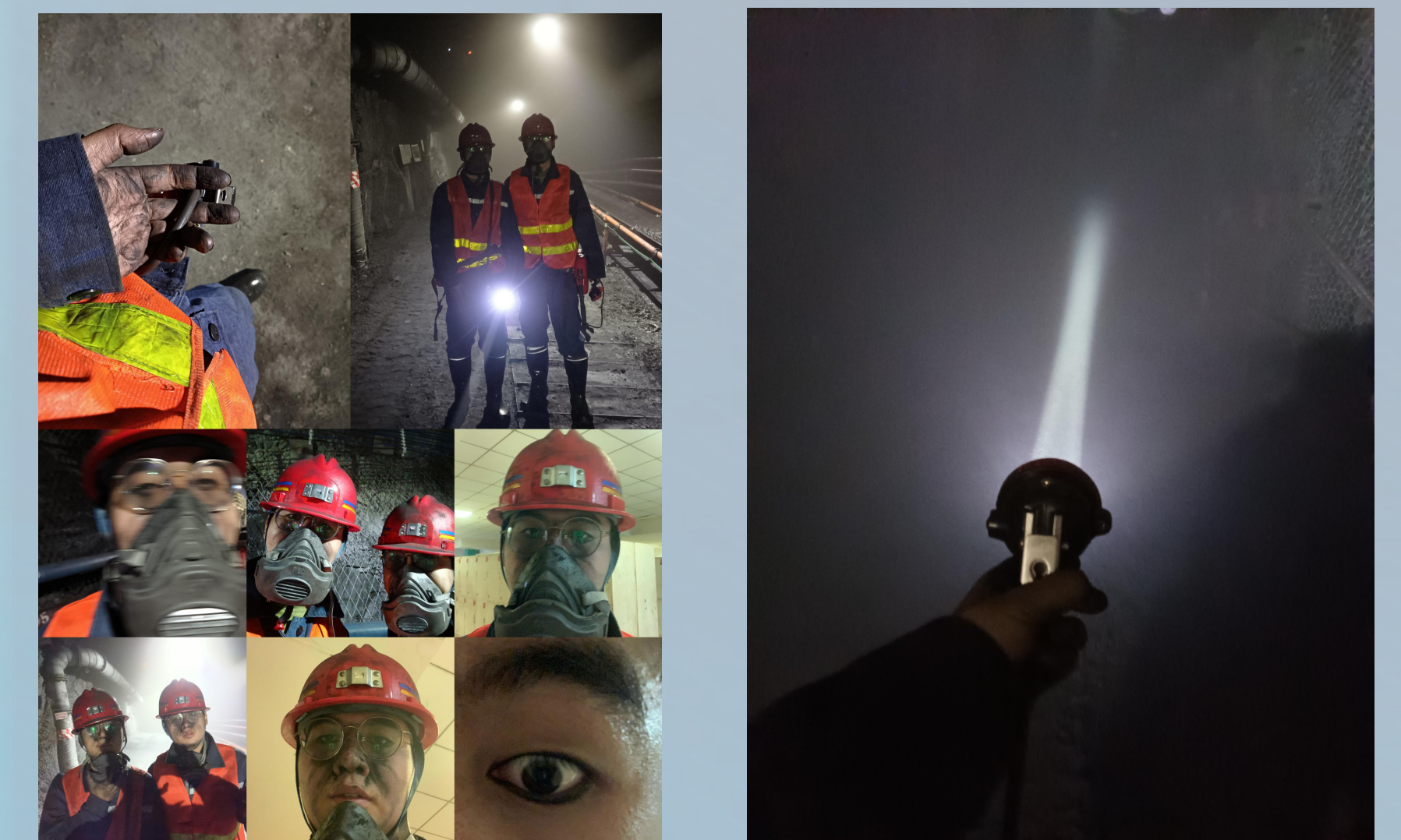
B mine three zone monitoring division diagram

The distribution of spontaneous combustion in goaf is "three zones"

Location	Zone of diffusion (m)	Oxidative spontaneous combustion zone(m)	Suffocation zone(m)	Maximum width of oxidation spontaneous combustion zone (m)	Minimum propulsion speed (m/day)
Return air side	<25.5	25.5~87.0	>87.0	61.5	0.74

Interesting experience

I truly cherish these two images, which vividly capture my internship experience. I am grateful for my teammates who helped tackle this challenge together. Working as a miner is incredibly arduous. As you can see, each time we emerged from the mine, we were covered in soot, with coal dust in our nostrils and eyes that lingered for days. It's hard to imagine that miners work in such conditions every day. This experience deepened my understanding of the significance of my field, and I am committed to conducting meaningful research to enhance the safety and efficiency of miners' work.



Responsibility on the shoulders of miners



In this image, we see miners braving the scorching sun, dragging heavy pipes to assist with casing installation. Each of us is striving for a better life, and their shoulders bear not just the weight of the pipes, but also the responsibility of family. They endure hardship for the vision of a better future for their loved ones. This inspires me to cherish every opportunity I have, whether it's in learning or engaging with society. As Ralph Waldo Emerson said, "Life is a succession of lessons which must be lived to be understood." These experiences remind me to appreciate everything I have and to be grateful.

Acknowledgements

I would like to express my gratitude to my alma mater, China University of Mining and Technology (Beijing), and China Coal Group for providing me with this platform. I am especially thankful to my professors, Professor Tan and Professor Liu, for their guidance during my internship. I also want to thank my classmate, Chen Chaohuan, for working alongside me to complete the installation tasks underground.



John and Willie Leone Family
Department of Energy and Mineral Engineering